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Development of a Toolkit for Calculating Linear, Change-point Linear and Multiple-linear Inverse Building Energy Analysis Models

ASHRAE Research Project 1050-RP

Detailed Test Results

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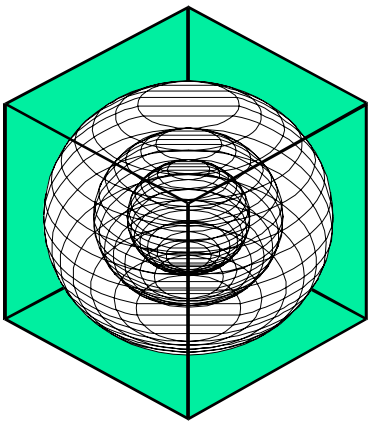

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PREFACE

This CD-ROM contains detailed test results of the Inverse Modeling Toolkit software (IMT), which was developed for ASHRAE Research Project 1050-RP. The test files included in the CD-ROM are divided into 15 subdirectories with their names referring to the types of models that were tested (i.e., 1P, 2P, 3P_COOL, 3P_HEAT, 3P_MVR, 4P, 4P_MVR, 5P, 5P_MVR, CDD, CDD_MVR, HDD, HDD_MVR, MVR, and Site_test). Each test that was performed consists of four different IMT file types, which include: 1) IMT instruction file (.INS), 2) IMT data file (.DAT), 3) IMT output file (IMT.OUT), and 4) IMT residual file (IMT.RES). The residual files are included for those tests that needed further testing or error checking, which is the case of CDD-MVR and HDD-MVR tests.

Some tests were performed to compare the results against those calculated by other programs, which include EModel (Kissock et al., 1996), SAS (SAS Institute Inc., 2001), and PRISM (Fels, M. et al., 1986). Each EModel test contains three files, including a data file (.DAT), an instruction file (.DVN), and an output file (.DOC). IMT and EModel share the same data file (.DAT). Each SAS run contains a procedure file (.SAS) and an output file (.LST) and also shares the same data file as IMT. For each PRISM run, there are three files included: a weather file (.TPS), a data file or meter file (.MTR), and an output file (.DOC).

This report is named "summary.doc" and it is located in the main directory of the CD-ROM. The IMT program is also included in this CD in the "IMT" subdirectory.

ABSTRACT

This is the detailed test report for the ASHRAE 1050-RP project. This report presents the detailed results of the testing of IMT (Inverse Modeling Toolkit). Two kinds of testing were performed, bounds testing and accuracy testing. The bounds testing is performed in order to identify what types of data sets the IMT program can model reliably. A variety of data sets were used to test the limits of the program: 1) Data sets with as few as two and as many as 9,000 data points, 2) Data sets with very large and very small numbers, 3) Data set with a variety of slopes, and 4) Data sets with tightly packed and widely scattered observations.

In terms of accuracy test, 1P, 2P and MVR models were benchmarked against the statistical software SAS (SAS Institute Inc., 2001). The change-point model results (3P and 4P) were compared to those calculated by the data analysis software EModel (Kissock et al., 1996). Finally, the IMT's HDD and CDD models were compared to PRISM HO and CO models (Fels, M. et al., 1986).

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2. SUMMARY

The results of each test are generally presented in two tables. One table, for example Table 1.1, contains a list of files used in performing the test, including types of data sets and tests and general comments about the results.

The "Data Type" column shows types of data sets and testing. The files with .INS and .DAT extensions are the IMT instruction and data files respectively. EModel and IMT share the same input data files, .DAT files, which are formatted, space-delimited ASCII text files. The .DOC files are the EModel output files, which are MS WORD document files. The files in the "SAS" column are the SAS input (.SAS) and output files (.LST), which can be opened with any text editor program. In addition, if PRISM was used in performing the test, for each PRISM run, there are three files included: a weather file (.TPS), a data file or meter file (.MTR), and an output file (.DOC). The “Status” column summarized the results of IMT as compared to other programs used.

In Table 1.2, the detailed results from the IMT bounds testing are shown, along with the comparison testing with other programs (e.g., EModel, PRISM, and SAS).

- Table 1.1 contains a list of the files used in performing one-parameter (1P) and two-parameter (2P) tests of IMT against EModel and SAS. The input data for IMT are synthetic and generated with known values and coefficients in order to perform accuracy tests of IMT. The results indicate that the minimum number of observations for the Mean model is two data points. In terms of magnitude, IMT ran correctly and produced output of the numbers with absolute values as small as 3.3×10^{-57} and as large as 1×10^{18}. Each model was successfully tested using 9,000 observations. For the 2P model, IMT successfully modeled data sets with slopes greater than or less than zero, and slopes less than infinity (i.e., vertical). Following Table 1.1 is Table 1.2, which contains the detailed outputs from the three programs. Generally, IMT, EModel, and SAS produced outputs in good agreement with each other.

- Table 2.1 contains a list of the files used in performing three-parameter change-point cooling (3PC) and heating (3PH) model tests of IMT against EModel. The input data for IMT are synthetic and generated with known values and coefficients in order to perform accuracy tests of IMT. The results indicate that the minimum number of observations for the 3P model is five. In terms of magnitude, IMT ran correctly and produced output of the numbers with absolute values as small as 3.3×10^{-57} and as large as 1×10^{18}. Each model was successfully tested using 9,000 observations. For the 3P model, IMT successfully modeled data sets with slopes greater than or less than zero, and slopes less than infinity (i.e., vertical), but it failed to identify flat slopes (i.e., Slope A). Following Table 2.1 is Table 2.2, which contains the detailed outputs from the two programs. Generally, IMT and EModel produced outputs in good agreement with each other.

- Table 3.1 contains a list of the files used in performing four-parameter change-point (4P) models tests of IMT, also against EModel. The input data for IMT are synthetic and

generated with known values and coefficients in order to perform accuracy tests of IMT. The results indicate that the minimum number of observations for the 4P model is five. In terms of magnitude, IMT ran correctly and produced output of the numbers with absolute values as small as 3.3×10^{-57} and as large as 1×10^{18}. Each model was successfully tested using 9,000 observations. For the 4P model, IMT successfully modeled data sets with slopes greater than or less than zero, and slopes less than infinity (i.e., vertical), but it failed to identify flat slopes (i.e., Slope A). Following Table 3.1 is Table 3.2, which contains the detailed outputs from the two programs. Generally, IMT and EModel produced outputs in good agreement with each other.

- Table 4.1 contains a list of the files used in performing the IMT tests of five-parameter change-point (5P) and five-parameter with multiple variable regression models (5P/MVR). For the 5P model, the input data for IMT are synthetic and generated with known values and coefficients. The results indicate that the minimum number of observations for the 5P model is seven. In terms of magnitude, IMT ran correctly and produced output of the numbers with absolute values as small as 3.3×10^{-57} and as large as 1×10^{18}. Each model was successfully tested using 9,000 observations. For the 5P model, IMT successfully modeled data sets with slopes greater than or less than zero, and slopes less than infinity, but it failed to identify flat slopes (i.e., Slope A).

  For the five-parameter change-point with multiple variable regression models (5P/MVR), the input data were obtained from the LoanSTAR database. The building used for these tests was the Zachry Engineering Center, Texas A&M University for the period of 1/1/99 to 12/31/99. The dependent variable is the energy consumption of the VAV motor control center (MCC). The independent variables include outdoor temperature, humidity ratio, and solar radiation. The results indicated that the maximum number of independent variables is two. Following Table 4.1 are Table 4.2 and Table 4.3, which contain the detailed outputs from IMT. No comparison tests were run for the 5P/MVR model.

- Table 5.1 contains a list of the files used in performing the IMT tests of three-parameter change-point with multiple variable regression models (3P/MVR). The input data were obtained from the LoanSTAR database. For the 3PC/MVR model, the dependent variable is the whole-building cooling energy consumption (WBC). The independent variables include outdoor temperature, humidity ratio, solar radiation, whole-building heating energy (WBH), and whole-building electricity consumption (WBE). For the 3PH/MVR model, the dependent variable is the whole-building heating energy consumption (WBH). The independent variables include outdoor temperature, humidity ratio, and solar radiation. The results indicated that the maximum number of independent variables is four. Following Table 5.1 is Table 5.2, which contains the detailed outputs from IMT. No comparison tests were run for the 3P/MVR model.

- Table 6.1 contains a list of the files used in performing the IMT tests of four-parameter change-point with multiple variable regression models (4P/MVR). The input data were obtained from the LoanSTAR database. For the 4PC/MVR model, the dependent variable is the whole-building cooling energy consumption (WBC). The independent variables

include outdoor temperature, humidity ratio, solar radiation, whole-building heating energy (WBH), and whole-building electricity consumption (WBE). For the 4PH/MVR model, the dependent variable is the whole-building heating energy consumption (WBH). The independent variables include outdoor temperature, humidity ratio, and solar radiation. The results indicated that the maximum number of independent variables is three. Following Table 6.1 is Table 6.2, which contains the detailed outputs from IMT. No comparison tests were run for the 4P/MVR model.

- Table 7.1 contains a list of the files used in performing the IMT tests against EModel and SAS of real data using several models (e.g., 1P, 2P, 3PC, 3PH, 4P, and 5P). The input data were obtained from several LoanSTAR buildings. The "Data Type" column shows LoanSTAR building ID and data channels that were used. Generally, IMT, EModel, and SAS produced outputs in good agreement with each other. Following Table 7.1 is Table 7.2, which contains the detailed outputs from IMT, EModel, and SAS.

- Table 8.1 contains a list of the files used in performing the IMT tests of the Variable-Base Cooling Degree-Day Model (CDD) and the CDD with multiple variable regression model (CDD/MVR). For the CDD model, IMT was benchmarked against PRISM. The utility data that were used as input data for IMT were obtained from a residential building located in College Station, Texas. In order to compare with PRISM CO model, the input data were prepared for two data sets. One contains energy use per billing periods (Q) to match the slope coefficients, and the other contains energy use per day (Q/day) to match the base use coefficients. Table 8.2 contains all detailed output values from the two programs. Generally, IMT and PRISM produced outputs in good agreement with each other.

  For the CDD model with multiple variable regression model (CDD/MVR), the CDD model was run, then a residual file was used as input to the MVR model in order to produce CDD-MVR capabilities. The input data were obtained from a LoanSTAR building. The dependent variable is the whole building cooling energy consumption (WBC). The independent variables include outdoor temperature, humidity ratio, and solar radiation. Table 8.3 contains the detailed outputs from the IMT program. No comparison tests were performed for this model.

- Table 9.1 contains a list of the files used in performing the IMT tests of the Variable-Base Heating Degree-Day Model (HDD) and the HDD with multiple variable regression model (HDD/MVR). For the HDD model, IMT was benchmarked against PRISM. The utility data that were used as input data for IMT were obtained from a residential building located in College Station, Texas. In order to compare with PRISM HO model, the input data were prepared for two data sets. One contains energy use per billing periods (Q) to match the slope coefficients, and the other contains energy use per day (Q/day) to match the base use coefficients. Table 9.2 contains the detailed outputs from the two programs. Generally, IMT and PRISM produced outputs in good agreement with each other.

For the HDD model with multiple variable regression model (HDD/MVR), the HDD model was run, then a residual file was used as input to the MVR model in order to produce HDD-MVR capabilities. The input data were obtained from the LoanSTAR database. The dependent variable is the whole-building heating energy consumption (WBH). The independent variables include outdoor temperature, humidity ratio, and solar radiation. Table 9.3 contains the detailed outputs from the IMT program. No comparison tests were performed for this model.

- Table 10.1 contains a list of the files used in performing the IMT tests against EModel and SAS using the Multiple Variable Regression Model (MVR). The input data are both synthetic and real data. For real data testing, the input data were obtained from the LoanSTAR database. IMT ran and produced outputs successfully without error. EModel failed to run the MLR model with the real data sets. Following Table 10.1 is Table 10.2, which contains the detailed outputs from the three programs. Generally, IMT, EModel, and SAS produced outputs in good agreement with each other.

3. REFERENCES

Kissock, K., Wu, E., Sparks, R., and Patel, D. (1996). *EModel version 1.4 D*. College Station, TX: Texas A&M University, Energy Systems Laboratory.

Fels, M., Reynolds, C., and Stram, D. (1986). PRISMonPC. Documentation for heating-only or cooling-only estimation program: Version 4.0. *PU/CEES Report # 213A.* Princeton, NJ: The Center for Energy and Environmental Studies, The Engineering Quadrangle, Princeton University.

SAS Institute Inc. (2001). *SAS user manual.* Metairie, LA.

APPENDIX A.

SUMMARY TABLES

Table 1.1: One-parameter (1P) and two-parameter (2P) models

			IMT		EModel			SAS		Status			
TEST		Data Type	IMT file	Data File	Data File	.DVN File	Output	SAS File	SAS output	IMT	EModel	SAS	Comment for IMT
1P	1P_test0	Synthetic: 1-point	1P_test0.ins	1P_test0.dat	1P_test0.dat	1P_test0.dvn	1P_test0.doc	1P_test0.sas	1P_test0.lst	Stop	OK	agree	Program cannot run. Error message shows illegal operation; Access Violation. IMT needs at least 2 points
	1P_test1	Synthetic: 2-point	1P_test1.ins	1P_test1.dat	1P_test1.dat	1P_test1.dvn	1P_test1.doc	1P_test1.sas	1P_test1.lst	OK	agree	agree	
	1P_test2	Synthetic: Scattered	1P_test2.ins	1P_test2.dat	1P_test2.dat	1P_test2.dvn	1P_test2.doc	1P_test2.sas	1P_test2.lst	OK	agree	agree	
	1P_test3	Synthetic: Packed	1P_test3.ins	1P_test3.dat	1P_test3.dat	1P_test3.dvn	1P_test3.doc	1P_test3.sas	1P_test3.lst	OK	agree	agree	
	1P_test4	Synthetic: 9,000-point	1P_test4.ins	1P_test4.dat	1P_test4.dat	1P_test4.dvn	1P_test4.doc	1P_test4.sas	1P_test4.lst	OK	agree	agree	
	1P_test5	Synthetic: Large	1P_test5.ins	1P_test5.dat	1P_test5.dat	1P_test5.dvn	1P_test5.doc	1P_test5.sas	1P_test5.lst	OK	agree	agree	IMT can run 18-digit numbers, but the output is F10.3, hence largest output is 999,999.999.
	1P_test6	Synthetic: Small	1P_test6.ins	1P_test6.dat	1P_test6.dat	1P_test6.dvn	1P_test6.doc	1P_test6.sas	1P_test6.lst	OK	agree	agree	IMT can run 57-decimal point number, output is F10.3 hence smallest output is 0.001.
2P	2P_test0	Synthetic: 2-point	2P_test0.ins	2P_test0.dat	2P_test0.dat	2P_test0.dvn	2P_test0.doc	2P_test0.sas	2P_test0.lst	OK	Overflow	agree	
	2P_test1	Synthetic: 3-point	2P_test1.ins	2P_test1.dat	2P_test1.dat	2P_test1.dvn	2P_test1.doc	2P_test1.sas	2P_test1.lst	OK	agree	agree	
	2P_test2	Synthetic: Scattered	2P_test2.ins	2P_test2.dat	2P_test2.dat	2P_test2.dvn	2P_test2.doc	2P_test2.sas	2P_test2.lst	OK	agree	agree	
	2P_test3	Synthetic: Packed	2P_test3.ins	2P_test3.dat	2P_test3.dat	2P_test3.dvn	2P_test3.doc	2P_test3.sas	2P_test3.lst	OK	agree	agree	
	2P_test4	Synthetic: 9,000-point	2P_test4.ins	2P_test4.dat	2P_test4.dat	2P_test4.dvn	2P_test4.doc	2P_test4.sas	2P_test4.lst	OK	agree	agree	
	2P_test5	Synthetic: Large	2P_test5.ins	2P_test5.dat	2P_test5.dat	2P_test5.dvn	2P_test5.doc	2P_test5.sas	2P_test5.lst	OK	disagree	disagree	IMT can run 18-digit numbers, but the output is F12.4, hence largest output is 9,999,999.9999.
	2P_test6	Synthetic: Small	2P_test6.ins	2P_test6.dat	2P_test6.dat	2P_test6.dvn	2P_test6.doc	2P_test6.sas	2P_test6.lst	OK	agree	agree	IMT can run 57-decimal point number, but output is F12.4 hence smallest output is 0.0001.
	2P_test7	Synthetic: Max Size (X)	2P_test7.ins	2P_test7.dat	2P_test7.dat	2P_test7.dvn	2P_test7.doc	2P_test7.sas	2P_test7.lst	OK	Overflow	agree	Program can run the maximum X value of about 20,000,000.
	2P_test8	Synthetic: Max Size (Y)	2P_test8.ins	2P_test8.dat	2P_test8.dat	2P_test8.dvn	2P_test8.doc	2P_test8.sas	2P_test8.lst	OK	Overflow	agree	IMT can run 19-digit number, but the output is F12.4, hence largest output is 9,999,999.9999
	2P_test9	Synthetic: Slope A = 0	2P_test9.ins	2P_test9.dat	2P_test9.dat	2P_test9.dvn	2P_test9.doc	2P_test9.sas	2P_test9.lst	Stop	agree	agree	Program stops with no error message.
	2P_test10	Synthetic: Slope B = infinite	2P_test10.ins	2P_test10.dat	2P_test10.dat	2P_test10.dvn	2P_test10.doc	2P_test10.sas	2P_test10.lst	OK	N/A	N/A	IMT runs, but slope and intercept numbers are meaningless
	2P_test11	Synthetic: Slope C = 1	2P_test11.ins	2P_test11.dat	2P_test11.dat	2P_test11.dvn	2P_test11.doc	2P_test11.sas	2P_test11.lst	OK	agree	agree	
	2P_test12	Synthetic: Slope D = -1	2P_test12.ins	2P_test12.dat	2P_test12.dat	2P_test12.dvn	2P_test12.doc	2P_test12.sas	2P_test12.lst	OK	agree	agree	

Table 1.2: One-parameter (1P) and two-parameter (2P) models

TEST		Data Type	IMT		EModel		SAS	
1P	1P_test0	Synthetic: 1-point	N/A	N/A	Mean = 5.25, Std Dev = 0.00, CV-StDev = 0.0%	agree	Mean = 5.25, Std Dev = 0.00, CV-StDev = 0.0%	agree
	1P_test1	Synthetic: 2-point	Mean = 5.100, Std Dev = 0.141, CV-StDev = 2.773%	OK	Mean = 5.10, Std Dev = 0.14, CV-StDev = 2.8%	agree	Mean = 5.1, Std Dev = 0.14142136, CV-StDev = 2.77296777%	agree
	1P_test2	Synthetic: Scattered	Mean = 4.718, Std Dev = 2.829, CV-StDev = 59.975%	OK	Mean = 4.72, Std Dev = 2.83, CV-StDev = 60.0%	agree	Mean = 4.71769, Std Dev = 2.82943194, CV-StDev = 59.9749441%	agree
	1P_test3	Synthetic: Packed	Mean = 4.983, Std Dev = 0.279, CV-StDev = 5.601%	OK	Mean = 4.98, Std Dev = 0.28, CV-StDev = 5.6%	agree	Mean = 4.982722, Std Dev = 0.27905763, CV-StDev = 5.60050567%	agree
	1P_test4	Synthetic: 9,000-point	Mean = 5.087, Std Dev = 2.898, CV-StDev = 56.969%	OK	Mean = 5.09, Std Dev = 2.90, CV-StDev = 57.0%	agree	Mean = 5.08703221, Std Dev = 2.89804482, CV-StDev = 56.9692641%	agree
	1P_test5	Synthetic: Large	Mean = 67297.289, Std Dev = 137075.516, CV-StDev = 203.687%	OK	Mean = 67297.29, Std Dev = 137075.52, CV-StDev = 203.7%	agree	Mean = 67297.2857, Std Dev = 137075.521, CV-StDev = 203.686552%	agree
	1P_test6	Synthetic: Small	Mean = 0.001, Std Dev = 0.008, CV-StDev = 715.378%	OK	Mean = 0.00, Std Dev = 0.01, CV-StDev = 715.4%	agree	Mean = 0.00112609, Std Dev = 0.00805578, CV-StDev = 715.378489%	agree
2P	2P_test0	Synthetic: 2-point	Slope = 1.0000, Intercept = 2.0000, CV-RMSE = 0.000%, R^2 = 1.000	OK	N/A	N/A	Slope = 1.00000, Intercept = 2.00000, CV-RMSE = 0.0%, R^2 = 1.0000	agree
	2P_test1	Synthetic: 3-point	Slope = 1.0000, Intercept = 2.0000, CV-RMSE = 0.000%, R^2 = 1.000	OK	Slope = 1.0000, Intercept = 2.0000, CV-RMSE = 0.000%, R^2 = 1.000	agree	Slope = 1.00000, Intercept = 2.00000, CV-RMSE = 0.0%, R^2 = 1.0000	agree
	2P_test2	Synthetic: Scattered	Slope = 1.4975, Intercept = 35.6834, CV-RMSE = 39.298%, R^2 = 0.366	OK	Slope = 1.4975, Intercept = 35.6834, CV-RMSE = 39.3%, R^2 = 0.37	agree	Slope = 1.49750, Intercept = 35.68344, CV-RMSE = 39.298%, R^2 = 0.366	agree
	2P_test3	Synthetic: Packed	Slope = 1.0050, Intercept = 2.3368, CV-RMSE = 1.038%, R^2 = 1.000	OK	Slope = 1.0050, Intercept = 2.3368, CV-RMSE = 1.0%, R^2 = 1.00	agree	Slope = 1.00498, Intercept = 2.33684, CV-RMSE = 1.03810%, R^2 = 0.9996	agree
	2P_test4	Synthetic: 9,000-point	Slope = 1.0000, Intercept = 2.0000, CV-RMSE = 0.000%, R^2 = 1.000	OK	Slope = 1.0000, Intercept = 2.0000, CV-RMSE = 0.0%, R^2 = 1.00	agree	Slope = 1.00000, Intercept = 2.00000, CV-RMSE = 0%, R^2 = 1.0000	agree
	2P_test5	Synthetic: Large	Slope = 1.0000, Intercept = -2.8669, CV-RMSE = 0.000%, R^2 = 1.000	OK	Slope = 1.0000, Intercept = 1.0101, CV-RMSE = 0.0%, R^2 = 1.000	disagree	Slope = 1.0000, Intercept = 1.01013, CV-RMSE = 0%, R^2 = 1.0000	disagree
	2P_test6	Synthetic: Small	Slope = 1.0000, Intercept = 0.0000, CV-RMSE = 0.000%, R^2 = 1.000	OK	Slope = 1.0000, Intercept = 0.0000, CV-RMSE = 0.000%, R^2 = 1.000	agree	Slope = 1.0000, Intercept = 0.0000, CV-RMSE = 0.000%, R^2 = 1.000	agree
	2P_test7	Synthetic: Max Size (X)	N/A	N/A	N/A	N/A	Slope = 4.019652E-7, Intercept = 1.50000, CV-RMSE = 0.000%, R^2 = 1.0000	agree
	2P_test8	Synthetic: Max Size (Y)	Slope = 111111.0078, Intercept = -111110.0313, CV-RMSE = 0.000%, R^2 = 1.000	OK	N/A	N/A	Slope = 111111, Intercept = -111110, CV-RMSE = 0%, R^2 = 1.0000	agree
	2P_test9	Synthetic: Slope A = 0	N/A	N/A	Slope = 0.0000, Intercept = 5.0000, CV-RMSE = 0.0%, R^2 = 0.00	agree	Slope = 0, Intercept = 5.00000, CV-RMSE = 0.0%, R^2 = 0	agree
	2P_test10	Synthetic: Slope B = inf	Slope = 5100.0000, Intercept = 127500.0000, CV-RMSE = N/A, R^2 = N/A	OK	N/A	N/A	N/A	N/A
	2P_test11	Synthetic: Slope C = 1	Slope = 1.0000, Intercept = 0.0000, CV-RMSE = 0.000%, R^2 = 1.000	OK	Slope = 1.0000, Intercept = 0.0000, CV-RMSE = 0.000%, R^2 = 1.000	agree	Slope = 1.0000, Intercept = 0.0000, CV-RMSE = 0.000%, R^2 = 1.000	agree
	2P_test12	Synthetic: Slope D = -1	Slope = -1.0000, Intercept = 51.0000, CV-RMSE = 0.000%, R^2 = 1.000	OK	Slope = -1.0000, Intercept = 51.0000, CV-RMSE = 0.0%, R^2 = 1.00	agree	Slope = -1.00000, Intercept = 51.00000, CV-RMSE = 0%, R^2 = 1.0000	agree

Table 2.1: Three-parameter change-point cooling (3PC) and three-parameter change-point heating (3PH) models

			IMT		EModel			Status		
TEST		**Data Type**	**IMT file**	**Data File**	**Data File**	**.DVN File**	**Output**	**IMT**	**EModel**	**Comment for IMT**
3PC	3PC_test0	Synthetic: 3-point	3PC_test0.ins	3PC_test0.dat	3PC_test0.dat	3PC_test0.dvn	3PC_test0.doc	Stop	Overflow	Unknown Floating Exception
	3PC_test1	Synthetic: 5-point	3PC_test1.ins	3PC_test1.dat	3PC_test1.dat	3PC_test1.dvn	3PC_test1.doc	OK	agree	
	3PC_test2	Synthetic: Scattered	3PC_test2.ins	3PC_test2.dat	3PC_test2.dat	3PC_test2.dvn	3PC_test2.doc	OK	agree	
	3PC_test3	Synthetic: Packed	3PC_test3.ins	3PC_test3.dat	3PC_test3.dat	3PC_test3.dvn	3PC_test3.doc	OK	agree	
	3PC_test4	Synthetic: 9,000-point	3PC_test4.ins	3PC_test4.dat	3PC_test4.dat	3PC_test4.dvn	3PC_test4.doc	OK	agree	
	3PC_test5	Synthetic: Large	3PC_test5.ins	3PC_test5.dat	3PC_test5.dat	3PC_test5.dvn	3PC_test5.doc	OK	agree	IMT can run 18-digit numbers, but the output is F12.4, hence largest output is 9,999,999.9999.
	3PC_test6	Synthetic: Small	3PC_test6.ins	3PC_test6.dat	3PC_test6.dat	3PC_test6.dvn	3PC_test6.doc	OK	agree	IMT can run 16-decimal point numbers, but output is F12.4 hence smallest output is 0.0001
	3PC_test7	Synthetic: Max Size (X)	3PC_test7.ins	3PC_test7.dat	3PC_test7.dat	3PC_test7.dvn	3PC_test7.doc	OK	agree	IMT can run 19-digit numbers, but the output is F12.4, hence largest output is 9,999,999.9999.
	3PC_test8	Synthetic: Max Size (Y)	3PC_test8.ins	3PC_test8.dat	3PC_test8.dat	3PC_test8.dvn	3PC_test8.doc	OK	agree	IMT can run 18-digit numbers, but the output is F12.4, hence largest output is 9,999,999.9999.
	3PC_test9	Synthetic: Slope A = 0	3PC_test9.ins	3PC_test9.dat	3PC_test9.dat	3PC_test9.dvn	3PC_test9.doc	Stop	OK	Floating point devided by 0
	3PC_test10	Synthetic: Slope B = infinite	3PC_test10.ins	3PC_test10.dat	3PC_test10.dat	3PC_test10.dvn	3PC_test10.doc	OK	agree	xcp is close by slope is wrong
	3PC_test11	Synthetic: Slope C = infinite	3PC_test11.ins	3PC_test11.dat	3PC_test11.dat	3PC_test11.dvn	3PC_test11.doc	OK	agree	xcp is close by slope is wrong
	3PC_test12	Synthetic: Slope D = -1	3PC_test12.ins	3PC_test12.dat	3PC_test12.dat	3PC_test12.dvn	3PC_test12.doc	OK	agree	
3PH	3PH_test0	Synthetic: 3-point	3PH_test0.ins	3PH_test0.dat	3PH_test0.dat	3PH_test0.dvn	3PH_test0.doc	Stop	Overflow	Unknown Floating Point Exception
	3PH_test1	Synthetic: 5-point	3PH_test1.ins	3PH_test1.dat	3PH_test1.dat	3PH_test1.dvn	3PH_test1.doc	OK	agree	
	3PH_test2	Synthetic: Scattered	3PH_test2.ins	3PH_test2.dat	3PH_test2.dat	3PH_test2.dvn	3PH_test2.doc	OK	agree	
	3PH_test3	Synthetic: Packed	3PH_test3.ins	3PH_test3.dat	3PH_test3.dat	3PH_test3.dvn	3PH_test3.doc	OK	agree	
	3PH_test4	Synthetic: 9,000-point	3PH_test4.ins	3PH_test4.dat	3PH_test4.dat	3PH_test4.dvn	3PH_test4.doc	OK	agree	
	3PH_test5	Synthetic: Large	3PH_test5.ins	3PH_test5.dat	3PH_test5.dat	3PH_test5.dvn	3PH_test5.doc	OK	agree	IMT can run 18-digit numbers, but the output is F12.4, hence largest output is 9,999,999.9999.
	3PH_test6	Synthetic: Small	3PH_test6.ins	3PH_test6.dat	3PH_test6.dat	3PH_test6.dvn	3PH_test6.doc	OK	agree	IMT can run 16-decimal point numbers, but output is F12.4 hence smallest output is 0.0001
	3PH_test7	Synthetic: Max Size (X)	3PH_test7.ins	3PH_test7.dat	3PH_test7.dat	3PH_test7.dvn	3PH_test7.doc	OK	agree	IMT can run 19-digit numbers, but the output is F12.4, hence largest output is 9,999,999.9999.
	3PH_test8	Synthetic: Max Size (Y)	3PH_test8.ins	3PH_test8.dat	3PH_test8.dat	3PH_test8.dvn	3PH_test8.doc	OK	agree	IMT can run 18-digit numbers, but the output is F12.4, hence largest output is 9,999,999.9999.
	3PH_test9	Synthetic: Slope A = 0	3PH_test9.ins	3PH_test9.dat	3PH_test9.dat	3PH_test9.dvn	3PH_test9.doc	Stop	OK	Program stops responding, but EModel runs OK
	3PH_test10	Synthetic: Slope B = infinite	3PH_test10.ins	3PH_test10.dat	3PH_test10.dat	3PH_test10.dvn	3PH_test10.doc	OK	agree	xcp is close but slope is wrong
	3PH_test11	Synthetic: Slope C = infinite	3PH_test11.ins	3PH_test11.dat	3PH_test11.dat	3PH_test11.dvn	3PH_test11.doc	OK	agree	xcp is close but slope is wrong
	3PH_test12	Synthetic: Slope D = 1	3PH_test12.ins	3PH_test12.dat	3PH_test12.dat	3PH_test12.dvn	3PH_test12.doc	OK	agree	

Table 2.2: Three-parameter change-point cooling (3PC) and three-parameter change-point heating (3PH) models

TEST		Data Type	IMT		EModel	
3PC	3PC_test0	Synthetic: 3-point	N/A	Stop	N/A	Overflow
	3PC_test1	Synthetic: 5-point	Ycp = 5.0077, LS = 0.0000, RS = 1.0136, Xcp = 10.1200, R^2 =1.000, CV-RMSE = 0.38%	OK	Ycp = 5.0077, LS = 0.0000, RS = 1.0136, Xcp = 10.1200, R^2 =1.00, CV-RMSE = 0.4%	agree
	3PC_test2	Synthetic: Scattered	Ycp = 44.0362, LS = 0.0000, RS = 3.4570, Xcp = 24.5200, R^2 = 0.547, CV-RMSE = 40.237%	OK	Ycp = 44.0362, LS = 0.0000, RS = 3.4570, Xcp = 24.52, R^2 = 0.55, CV-RMSE = 40.2%	agree
	3PC_test3	Synthetic: Packed	Ycp = 27.4776, LS = 0.0000, RS = 1.0379, Xcp = 25.5000, R^2 = 0.999, CV-RMSE = 0.854%	OK	Ycp = 27.4776, LS = 0.0000, RS = 1.0379, Xcp = 25.5000, R^2 = 1.0, CV-RMSE = 0.9%	agree
	3PC_test4	Synthetic: 9,000-point	Ycp = 4.9997, LS = 0.0000, RS = 0.9996, Xcp = 4.9984, R^2 = 1.000, CV-RMSE = 0.008%	OK	Ycp = 4.9997, LS = 0.0000, RS = 0.9996, Xcp = 4.9984, R^2 = 1.00, CV-RMSE = 0.0%	agree
	3PC_test5	Synthetic: Large	Ycp = 443143.7500, LS = 0.0000, RS = 1.0000, Xcp = 443145.4688, R^2 = 1.000, CV-RMSE = 0.000%	OK	Ycp = 443143.7328, LS = 0.0000, RS = 1.0000, Xcp = 443145.45, R^2 = 1.00, CV-RMSE = 0.0%	agree
	3PC_test6	Synthetic: Small	Ycp = 0.0005, LS = 0.0000, RS = 1.0039, Xcp = 0.0005, R^2 = 1.000, CV-RMSE = 0.084%	OK	Ycp = 0.0005, LS = 0.0000, RS = 1.0039, Xcp = 0.0005, R^2 = 1.00, CV-RMSE = 0.1%	agree
	3PC_test7	Synthetic: Max Size (X)	Ycp = 5.0091, LS = 0.0000, RS = 1.0039, Xcp = 5004678.50, R^2 = 1.000, CV-RMSE = 0.190%	OK	Ycp = 5.0091, LS = 0.0000, RS = 1.0039, Xcp = 5004678.78, R^2 = 1.000, CV-RMSE = 0.2%	agree
	3PC_test8	Synthetic: Max Size (Y)	Ycp = 4996527.00, LS = 0.0000, RS = 986543.8125, Xcp = 5.0045, R^2 = 1.000, CV-RMSE = 0.169%	OK	Ycp = 4996526.875, LS = 0.0000, RS = 986543.9533, Xcp = 5.0045, R^2 = 1.000, CV-RMSE = 0.2%	agree
	3PC_test9	Synthetic: Slope A = 0	N/A	Stop	Ycp = 5.0000, LS = 0.0000, RS = 0.0000, Xcp = 26.4800, R^2 = 0.00, CV-RMSE = 0.0%	agree
	3PC_test10	Synthetic: Slope B = inf	Ycp = 25.00, LS = 0.0000, RS = 13.0208, Xcp = 24.0400, R^2 = 0.571, CV-RMSE = 17.523%	OK	Ycp = 25.00, LS = 0.0000, RS = 13.0208, Xcp = 24.0400, R^2 = 0.57, CV-RMSE = 17.5%	agree
	3PC_test11	Synthetic: Slope C = inf	Ycp = 25.00, LS = 0.0000, RS = -12.0192, Xcp = 24.0400, R^2 = 0.536, CV-RMSE = 28.812%	OK	Ycp = 25.00, LS = 0.0000, RS = -12.0192, Xcp = 24.0400, R^2 = 0.54, CV-RMSE = 28.8%	agree
	3PC_test12	Synthetic: Slope D = -1	Ycp = 24.9103, LS = 0.0000, RS = -1.0244, Xcp = 26.48, R^2 = 1.000, CV-RMSE = 0.804%	OK	Ycp = 24.9103, LS = 0.0000, RS = -1.0244, Xcp = 26.48, R^2 = 1.00, CV-RMSE = 0.8%	agree
3PH	3PH_test0	Synthetic: 3-point	N/A	Stop	N/A	Overflow
	3PH_test1	Synthetic: 5-point	Ycp = 5.0016, LS = -1.2535, RS = 0.0000, Xcp = 8.9800, R^2 = 1.0000, CV-RMSE = 0.078%	OK	Ycp = 5.0016, LS = -1.2535, RS = 0.0000, Xcp = 8.9800, R^2 = 1.0000, CV-RMSE = 0.1%	agree
	3PH_test2	Synthetic: Scattered	Ycp = 77.4479, LS = -2.9475, RS = 0.0000, Xcp = 25.5000, R^2 = 0.407, CV-RMSE = 30.563%	OK	Ycp = 77.4479, LS = -2.9475, RS = 0.0000, Xcp = 25.5000, R^2 = 0.41, CV-RMSE = 30.6%	agree
	3PH_test3	Synthetic: Packed	Ycp = 30.0132, LS = -3.0545, RS = 0.0000, Xcp = 24.5200, R^2 = 0.9850, CV-RMSE = 6.168%	OK	Ycp = 30.0132, LS = -3.0545, RS = 0.0000, Xcp = 24.5200, R^2 = 0.99, CV-RMSE = 6.2%	agree
	3PH_test4	Synthetic: 9,000-point	Ycp = 5.0063, LS = -0.9989, RS = 0.0000, Xcp = 4.9984, R^2 = 0.969, CV-RMSE = 4.626%	OK	Ycp = 5.0063, LS = -0.9989, RS = 0.0000, Xcp = 4.9984, R^2 = 0.97, CV-RMSE = 4.6%	agree
	3PH_test5	Synthetic: Large	Ycp = 9370096.00, LS = -1.0000, RS = 0.0000, Xcp = 9370100.00, R^2 = 1.000, CV-RMSE = 0.000%	OK	Ycp = 9370096.00, LS = -1.0000, RS = 0.0000, Xcp = 9370100.00, R^2 = 1.000, CV-RMSE = 0.000%	agree
	3PH_test6	Synthetic: Small	Ycp = 0.0005, LS = -0.9871, RS = 0.0000, Xcp = 0.0005, R^2 = 1.000, CV-RMSE = 0.451%	OK	Ycp = 0.0005, LS = -0.9871, RS = 0.0000, Xcp = 0.0005, R^2 = 1.000, CV-RMSE = 0.5%	agree
	3PH_test7	Synthetic: Max Size (X)	Ycp = 5.0000, LS = 0.0000, RS = 0.0000, Xcp = 5004678.500, R^2 = 1.000, CV-RMSE = 0.003%	OK	Ycp = 5.0000, LS = 0.0000, RS = 0.0000, Xcp = 5004678.7790, R^2 = 1.000, CV-RMSE = 0.0%	agree
	3PH_test8	Synthetic: Max Size (Y)	Ycp = 5004020.0000, LS = -992540.2500, RS = 0.0000, Xcp = 5.0045, R^2 = 1.000, CV-RMSE = 0.022%	OK	Ycp = 5004018.7144, LS = -992539.8949, RS = 0.0000, Xcp = 5.0045, R^2 = 1.000, CV-RMSE = 0.0%	agree
	3PH_test9	Synthetic: Slope A = 0	N/A	Stop	Ycp = 5.0000, LS = 0.0000, RS = 0.0000, Xcp = 30.4000, R^2 = 0.00, CV-RMSE = 0.0%	agree
	3PH_test10	Synthetic: Slope B = inf	Ycp = 25.0000, LS = -26.0417, RS = 0.0000, Xcp = 25.4800, R^2 = 0.571, CV-RMSE = 17.523%	OK	Ycp = 25.0000, LS = -26.0417, RS = 0.0000, Xcp = 25.4800, R^2 = 0.56, CV-RMSE = 17.5%	agree
	3PH_test11	Synthetic: Slope C = inf	Ycp = 25.0000, LS = 24.0000, RS = 0.0000, Xcp = 25.5000, R^2 = 0.581, CV-RMSE = 27.390%	OK	Ycp = 25.0000, LS = 24.0000, RS = 0.0000, Xcp = 25.5000, R^2 = 0.58, CV-RMSE = 27.4%	agree
	3PH_test12	Synthetic: Slope D = 1	Ycp = 24.9103, LS = 1.0244, RS = 0.0000, Xcp = 24.52, R^2 = 1.000, CV-RMSE = 0.804%	OK	Ycp = 24.9103, LS = 1.0244, RS = 0.0000, Xcp = 24.52, R^2 = 1.000, CV-RMSE = 0.8%	agree

Table 3.1: Four-parameter change-point (4P) model

			IMT		EModel			Status		
TEST		**Data Type**	**IMT file**	**Data File**	**Data File**	**.DVN File**	**Output**	**Status**	**EModel**	**Comment for IMT**
4P	4P_test0	Synthetic: 3-point	4P_test0.ins	4P_test0.dat	4P_test0.dat	4P_test0.dvn	4P_test0.doc	Wrong	Error	IMT returns wrong LS value. Emodel stops with a divided-by-zero comment
	4P_test1	Synthetic: 5-point	4P_test1.ins	4P_test1.dat	4P_test1.dat	4P_test1.dvn	4P_test1.doc	OK	OK	
	4P_test2	Synthetic: Scattered	4P_test2.ins	4P_test2.dat	4P_test2.dat	4P_test2.dvn	4P_test2.doc	OK	OK	
	4P_test3	Synthetic: Packed	4P_test3.ins	4P_test3.dat	4P_test3.dat	4P_test3.dvn	4P_test3.doc	OK	OK	
	4P_test4	Synthetic: 9,000-point	4P_test4.ins	4P_test4.dat	4P_test4.dat	4P_test4.dvn	4P_test4.doc	OK	OK	
	4P_test5	Synthetic: Large	4P_test5.ins	4P_test5.dat	4P_test5.dat	4P_test5.dvn	4P_test5.doc	OK	OK	IMT can run 18-digit numbers, but the output is F12.4, hence largest output is 9,999,999.9999.
	4P_test6	Synthetic: Small	4P_test6.ins	4P_test6.dat	4P_test6.dat	4P_test6.dvn	4P_test6.doc	OK	OK	IMT can run 16-decimal point numbers, but output is F12.4 hence smallest output is 0.0001
	4P_test7	Synthetic: Max Size (X)	4P_test7.ins	4P_test7.dat	4P_test7.dat	4P_test7.dvn	4P_test7.doc	OK	OK	IMT can run 19-digit numbers, but the output is F12.4, hence largest output is 9,999,999.9999.
	4P_test8	Synthetic: Max Size (Y)	4P_test8.ins	4P_test8.dat	4P_test8.dat	4P_test8.dvn	4P_test8.doc	OK	OK	IMT can run 18-digit numbers, but the output is F12.4, hence largest output is 9,999,999.9999.
	4P_test9	Synthetic: Slope A (flat)	4P_test9.ins	4P_test9.dat	4P_test9.dat	4P_test9.dvn	4P_test9.doc	Stop	OK	IMT stops responding.
	4P_test10	Synthetic: Slope B =1	4P_test10.ins	4P_test10.dat	4P_test10.dat	4P_test10.dvn	4P_test10.doc	OK	OK	
	4P_test11	Synthetic: Slope C = infinite	4P_test11.ins	4P_test11.dat	4P_test11.dat	4P_test11.dvn	4P_test11.doc	OK	OK	xcp is close by slope is wrong
	4P_test12	Synthetic: Slope D = infinite	4P_test12.ins	4P_test12.dat	4P_test12.dat	4P_test12.dvn	4P_test12.doc	OK	OK	xcp is close by slope is wrong
	4P_test13	Synthetic: Slope E = double	4P_test13.ins	4P_test13.dat	4P_test13.dat	4P_test13.dvn	4P_test13.doc	OK	OK	IMT slope is avg of double slopes
	4P_test14	Synthetic: Slope F = 1	4P_test14.ins	4P_test14.dat	4P_test14.dat	4P_test14.dvn	4P_test14.doc	OK	OK	
	4P_test15	Synthetic: Slope G = infinite	4P_test15.ins	4P_test15.dat	4P_test15.dat	4P_test15.dvn	4P_test15.doc	OK	OK	xcp is close but slope is wrong
	4P_test16	Synthetic: Slope H = infinite	4P_test16.ins	4P_test16.dat	4P_test16.dat	4P_test16.dvn	4P_test16.doc	OK	OK	xcp is close but slope is wrong
	4P_test17	Synthetic: Slope I = double	4P_test17.ins	4P_test17.dat	4P_test17.dat	4P_test17.dvn	4P_test17.doc	OK	OK	IMT slope is avg of double slopes

Table 3.2: Four-parameter change-point (4P) model

TEST		Data Type	IMT		EModel	
4P	4P_test0	Synthetic: 3-point	Ycp = 5.1867, LS = -11.5093, RS = 0.9993, Xcp = 5.2000, R^2 =1.000, CV-RMSE = 0.000%	Wrong	N/A	Error
	4P_test1	Synthetic: 5-point	Ycp = 10.000, LS = 0.5000, RS = 1.0000, Xcp = 10.0000, R^2 =1.000, CV-RMSE = 0.000%	OK	Ycp = 10.000, LS = 0.5000, RS = 1.0000, Xcp = 10.0000, R^2 =1.00, CV-RMSE = 0.0%	OK
	4P_test2	Synthetic: Scattered	Ycp = 62.1740, LS = 0.4749, RS = 4.5700, Xcp = 23.5400, R^2 = 0.721, CV-RMSE = 29.309%	OK	Ycp = 62.1739, LS = 0.4749, RS = 4.5700, Xcp = 23.5400, R^2 = 0.72, CV-RMSE = 29.3%	OK
	4P_test3	Synthetic: Packed	Ycp = 53.9740, LS = 0.5725, RS = 2.5368, Xcp = 52.9200, R^2 = 0.962, CV-RMSE = 12.307%	OK	Ycp = 53.9740, LS = 0.5725, RS = 2.5368, Xcp = 52.9200, R^2 = 0.96, CV-RMSE = 12.3%	OK
	4P_test4	Synthetic: 9,000-point	Ycp = 5.0115, LS = 0.3544, RS = 0.9912, Xcp = 4.9984, R^2 = 0.923, CV-RMSE = 9.897%	OK	Ycp = 5.0115, LS = 0.3544, RS = 0.9912, Xcp = 4.9984, R^2 = 0.92, CV-RMSE = 9.9%	OK
	4P_test5	Synthetic: Large	Ycp = 500468.2500, LS = 0.5000, RS = 1.0000, Xcp = 500468.0000, R^2 = 1.000, CV-RMSE = 0.000%	OK	Ycp = 500468.0219, LS = 0.5000, RS = 1.0000, Xcp = 500468.0000, R^2 = 1.00, CV-RMSE = 0.0%	OK
	4P_test6	Synthetic: Small	Ycp = 0.0000, LS = 0.5020, RS = 1.0017, Xcp = 0.0000, R^2 = 1.000, CV-RMSE = 0.053%	OK	Ycp = 0.0000, LS = 0.5020, RS = 1.0017, Xcp = 0.0000, R^2 = 1.00, CV-RMSE = 0.1%	OK
	4P_test7	Synthetic: Max Size (X)	Ycp = 5.0211, LS = 0.0000, RS = 0.0000, Xcp = 5004678.5000, R^2 = 1.000, CV-RMSE = 0.162%	OK	Ycp = 5.0211, LS = 0.0000, RS = 0.0000, Xcp = 5004678.7800, R^2 = 1.00, CV-RMSE = 0.2%	OK
	4P_test8	Synthetic: Max Size (Y)	Ycp = 4986407.0000, LS = 490802.1563, RS = 989593.0000, Xcp = 5.0045, R^2 = 1.000, CV-RMSE = 0.147%	OK	Ycp = 4986413.2746, LS = 490803.3669, RS = 989591.8723, Xcp = 5.0045, R^2 = 1.00, CV-RMSE = 0.1%	OK
	4P_test9	Synthetic: Slope A (flat)	N/A	Stop	Ycp = 5.0000, LS = 0.0000, RS = 0.000, Xcp = 5.0045, R^2 = 0.00, CV-RMSE = 0.0%	OK
	4P_test10	Synthetic: Slope B =1	Ycp = 24.7702, LS = 1.0156, RS = 0.0133, Xcp = 24.5200, R^2 = 1.000, CV-RMSE = 0.650%	OK	Ycp = 24.7702, LS = 1.0156, RS = 0.0133, Xcp = 24.5200, R^2 = 1.00, CV-RMSE = 0.7%	OK
	4P_test11	Synthetic: Slope C = infinite	Ycp = 24.0401, LS = 1.0000, RS = 14.0207, Xcp = 24.0400, R^2 = 0.860, CV-RMSE = 21.876%	OK	Ycp = 24.0400, LS = 1.0000, RS = 14.0208, Xcp = 24.0400, R^2 = 0.86, CV-RMSE = 21.9%	OK
	4P_test12	Synthetic: Slope D = infinite	Ycp = 24.0401, LS = 1.0000, RS = -11.0193, Xcp = 24.0400, R^2 = 0.447, CV-RMSE = 42.556%	OK	Ycp = 24.0401, LS = 1.0000, RS = -11.0192, Xcp = 24.0400, R^2 = 0.45, CV-RMSE = 42.6%	OK
	4P_test13	Synthetic: Slope E = double	Ycp = 47.2500, LS = 0.5000, RS = 0.5000, Xcp = 44.5000, R^2 = 0.200, CV-RMSE = 17.389%	OK	Ycp = 48.2500, LS = 0.5000, RS = 0.5000, Xcp = 46.5000, R^2 = 0.20, CV-RMSE = 17.4%	OK
	4P_test14	Synthetic: Slope F = 1	Ycp = 24.7498, LS = -0.0156, RS = 0.9867, Xcp = 24.5200, R^2 = 1.000, CV-RMSE = 0.392%	OK	Ycp = 24.7498, LS = -0.0156, RS = 0.9867, Xcp = 24.5200, R^2 = 1.00, CV-RMSE = 0.4%	OK
	4P_test15	Synthetic: Slope G = infinite	Ycp = 26.0118, LS = -10.0535, RS = 1.0008, Xcp = 26.0000, R^2 = 0.514, CV-RMSE = 14.080%	OK	Ycp = 26.0000, LS = -10.0400, RS = 1.0000, Xcp = 26.0000, R^2 = 0.51, CV-RMSE = 14.1%	OK
	4P_test16	Synthetic: Slope H = infinite	Ycp = 25.9759, LS = 12.9596, RS = 1.0016, Xcp = 26.0000, R^2 = 0.875, CV-RMSE = 20.625%	OK	Ycp = 26.0000, LS = 13.0000, RS = 1.0000, Xcp = 26.0000, R^2 = 0.88, CV-RMSE = 20.6%	OK
	4P_test17	Synthetic: Slope I = double	Ycp = 30.0001, LS = 0.5000, RS = 0.5000, Xcp = 35.0000, R^2 = 0.209, CV-RMSE = 24.027%	OK	Ycp = 25.2500, LS = 0.5000, RS = 0.5000, Xcp = 25.5000, R^2 = 0.21, CV-RMSE = 24.0%	OK

Table 4.1: Five-parameter change-point (5P) and five-parameter change-point with multiple variable regression models (5P/MVR)

			IMT		Status		
TEST		**Data Type**	**IMT file**	**Data File**	**IMT**	**EModel**	**Comment for IMT**
5P	5P_test0	Synthetic: 4-point	5P_test0.ins	5P_test0.dat	Stop	N/A	Unknow Floating Point Exception
	5P_test1	Synthetic: 7-point	5P_test1.ins	5P_test1.dat	OK	N/A	
	5P_test2	Synthetic: Scattered	5P_test2.ins	5P_test2.dat	OK	N/A	
	5P_test3	Synthetic: Packed	5P_test3.ins	5P_test3.dat	OK	N/A	
	5P_test4	Synthetic: 9,000-point	5P_test4.ins	5P_test4.dat	OK	N/A	
	5P_test5	Synthetic: Large	5P_test5.ins	5P_test5.dat	OK	N/A	IMT can run 18-digit numbers, but the output is F12.4, hence largest output is 9,999,999.9999.
	5P_test6	Synthetic: Small	5P_test6.ins	5P_test6.dat	OK	N/A	IMT can run 16-decimal point numbers, but output is F12.4 hence smallest output is 0.0001
	5P_test7	Synthetic: Max Size (X)	5P_test7.ins	5P_test7.dat	OK	N/A	IMT can run 19-digit numbers, but the output is F12.4, hence largest output is 9,999,999.9999.
	5P_test8	Synthetic: Max Size (Y)	5P_test8.ins	5P_test8.dat	OK	N/A	IMT can run 18-digit numbers, but the output is F12.4, hence largest output is 9,999,999.9999.
	5P_test9	Synthetic: Slope A (flat)	5P_test9.ins	5P_test9.dat	Stop	N/A	Floating point divided by zero
	5P_test10	Synthetic: Slope B = 2, inf	5P_test10.ins	5P_test10.dat	OK	N/A	xcp is close but slope is wrong
	5P_test11	Synthetic: Slope C = 2, inf	5P_test11.ins	5P_test11.dat	OK	N/A	xcp is close but slope is wrong
	5P_test12	Synthetic: Slope D =1, -1	5P_test12.ins	5P_test12.dat	OK	N/A	
	5P_test13	Synthetic: Slope E = 1,1	5P_test13.ins	5P_test13.dat	OK	N/A	
	5P_test14	Synthetic: Slope F = -1,-1	5P_test14.ins	5P_test14.dat	OK	N/A	
5P/MVR	5P_Mvr1	MCC/Temp	5P_Mvr1.ins	5P_Mvr1.dat	OK	N/A	
	5P_Mvr2	MCC/Hum.ratio	5P_Mvr2.ins	5P_Mvr2.dat	OK	N/A	
	5P_Mvr3	MCC/Solar	5P_Mvr3.ins	5P_Mvr3.dat	OK	N/A	
	5P_Mvr4	MCC/(temp, hum.ratio, solar)	5P_Mvr4.ins	5P_Mvr4.dat	Stop	N/A	For 5P model, Number of X variables must be greater than 0 and less than 3.
	5P_Mvr5	MCC/(temp, hum.ratio)	5P_Mvr5.ins	5P_Mvr5.dat	OK	N/A	

Table 4.2: Five-parameter change-point model (5P)

TEST		Data Type	IMT	
5P	5P_test0	Synthetic: 4-point	N/A	Stop
	5P_test1	Synthetic: 7-point	Xcp1 = 4.0743, Xcp2 = 6.9257, Ycp = 4.8723, LS = -2.4657, RS = 2.4657, R^2 = 0.999, CV-RMSE = 1.078%	OK
	5P_test2	Synthetic: Scattered	Xcp1 = 23.8116, Xcp2 = 27.0724, Ycp = 7.1445, LS = -0.8616, RS = 1.4693, R^2 = 0.465, CV-RMSE = 45.680%	OK
	5P_test3	Synthetic: Packed	Xcp1 = 17.2947, Xcp2 = 28.7053, Ycp = 13.6478, LS = -0.8945, RS = 1.0204, R^2 = 0.939, CV-RMSE = 7.164%	OK
	5P_test4	Synthetic: 9,000-point	Xcp1 = 2.9624, Xcp2 = 5.9237, Ycp = 2.9931, LS = -1.0216, RS = 0.9710, R^2 = 0.946, CV-RMSE = 6.798%	OK
	5P_test5	Synthetic: Large	Xcp1 = 3348554.5000, Xcp2 = 6660803.0000, Ycp = 3323121.2500, LS = -0.9901, RS = 1.0063, R^2 = 1.000, CV-RMSE = 0.153%	OK
	5P_test6	Synthetic: Small	Xcp1 = 0.0000, Xcp2 = 0.0000, Ycp = 0.0000, LS = -0.9902, RS = 1.0064, R^2 = 1.000, CV-RMSE = 0.000%	OK
	5P_test7	Synthetic: Max Size (X)	Xcp1 = 3348554.2500, Xcp2 = 6660803.0000, Ycp = 4.9983, LS = 0.0000, RS = 0.0000, R^2 = 1.000, CV-RMSE = 0.153%	OK
	5P_test8	Synthetic: Max Size (Y)	Xcp1 = 2.9826, Xcp2 = 7.0274, Ycp = 4993588.5000, LS = N/A, RS = 1008166.3750, R^2 = 1.000, CV-RMSE = 0.145%	OK
	5P_test9	Synthetic: Slope A (flat)	N/A	Stop
	5P_test10	Synthetic: Slope B = 2, inf	Xcp1 = 5.5556, Xcp2 = 9.4444, Ycp = 5.0000, LS = -8.2500, RS = 7.8000, R^2 = 0.195, CV-RMSE = 38.946%	OK
	5P_test11	Synthetic: Slope C = 2, inf	Xcp1 = 5.5556, Xcp2 = 9.4444, Ycp = 15.0000, LS = 8.2500, RS = -6.6000, R^2 = 0.182, CV-RMSE = 27.866%	OK
	5P_test12	Synthetic: Slope D =1, -1	Xcp1 = 15.6667, Xcp2 = 30.3333, Ycp = 15.2201, LS = 0.9558, RS = -0.9582, R^2 = 0.998, CV-RMSE = 2.231%	OK
	5P_test13	Synthetic: Slope E = 1,1	Xcp1 = 15.6667, Xcp2 = 30.3333, Ycp = 15.1639, LS = 0.9502, RS = 1.0159, R^2 = 1.000, CV-RMSE = 1.055%	OK
	5P_test14	Synthetic: Slope F = -1,-1	Xcp1 = 15.6667, Xcp2 = 30.3333, Ycp = 15.1626, LS = -1.0169, RS = 0.9501, R^2 = 0.999, CV-RMSE = 1.199%	OK

Table 4.3: Five-parameter change-point with multiple variable regression model (5P/MVR)

TEST		Data Type	IMT	
5P/MVR	5P_MVR1	MCC/temp	Xcp1 = 44.2178, Xcp2 = 52.5467, Ycp =107.2245, LS = 0.7187, RS = 2.3912, R^2 =0.632, CV-RMSE =14.301%	OK
	5P_MVR2	MCC/Hum.Ratio	Xcp1 = 0.0167, Xcp2 = 0.0189, Ycp =174.6631 LS = 4500.1250, RS = 2631.7185, R^2 =0.332, CV-RMSE = 19.275%	OK
	5P_MVR3	MCC/Solar	Xcp1 = 39.5037, Xcp2 = 157.7781, Ycp =158.6373, LS = 0.5226, RS = 0.0287, R^2 = 0.184, CV-RMSE = 21.311%	OK
	5P_MVR4	MCC/(temp, hum.ratio, solar)	N/A	Stop
	5P_MVR5	MCC/(temp, hum.ratio)	Xcp1 = 44.2178, Xcp2 = 52.5467, Ycp =104.8277, LS = 0.5614, RS = 2.2900, X2 = 357.1251R2 =0.634, CV-RMSE =14.275%	OK

Table 5.1: Three-parameter change-point with multiple variable regression model (3P/MVR)

			IMT		EModel			Status		
TEST		**Data Type**	**IMT file**	**Data File**	**Data File**	**.DVN File**	**Output**	**IMT**	**EModel**	**Comment for IMT**
3PC/MVR	3PC_MVR1	WBC/Temp	3PC_Mvr1.ins	3PC_Mvr1.dat	3PC_Mvr1.dat	3PC_Mvr1.dvn	3PC_Mvr1.doc	OK	agree	
	3PC_MVR2	WBC/Hum.Ratio	3PC_Mvr2.ins	3PC_Mvr2.dat	3PC_Mvr2.dat	3PC_Mvr2.dvn	3PC_Mvr2.doc	OK	agree	
	3PC_MVR3	WBC/Solar	3PC_Mvr3.ins	3PC_Mvr3.dat	3PC_Mvr3.dat	3PC_Mvr3.dvn	3PC_Mvr3.doc	OK	agree	
	3PC_MVR4	WBC/WBH	3PC_Mvr4.ins	3PC_Mvr4.dat	3PC_Mvr4.dat	3PC_Mvr4.dvn	3PC_Mvr4.doc	OK	agree	
	3PC_MVR5	WBC/WBE	3PC_Mvr5.ins	3PC_Mvr5.dat	3PC_Mvr5.dat	3PC_Mvr5.dvn	3PC_Mvr5.doc	OK	agree	
	3PC_MVR6	WBC/(temp, hum.ratio, solar, WBH, WBE)	3PC_Mvr6.ins	3PC_Mvr6.dat	N/A	N/A	N/A	Stop	N/A	For 3P model, Number of X variables must be greater than 0 and less than 5.
	3PC_MVR7	WBC/(temp, hum.ratio, solar, WBH)	3PC_Mvr7.ins	3PC_Mvr7.dat	N/A	N/A	N/A	OK	N/A	
3PH/MVR	3PH_MVR1	WBH/temp	3PH_Mvr1.ins	3PH_Mvr1.dat	3PH_Mvr1.dat	3PH_Mvr1.dvn	3PH_Mvr1.doc	OK	agree	
	3PH_MVR2	WBH/Hum.Ratio	3PH_Mvr2.ins	3PH_Mvr2.dat	3PH_Mvr2.dat	3PH_Mvr2.dvn	3PH_Mvr2.doc	OK	agree	
	3PH_MVR3	WBH/Solar	3PH_Mvr3.ins	3PH_Mvr3.dat	3PH_Mvr3.dat	3PH_Mvr3.dvn	3PH_Mvr3.doc	OK	agree	
	3PH_MVR4	WBH/(temp, hum.ratio, solar)	3PH_Mvr4.ins	3PH_Mvr4.dat	N/A	N/A	N/A	OK	N/A	

Table 5.2: Three-parameter change-point with multiple variable regression model (3P/MVR)

TEST		Data Type	IMT		EModel	
3PC/MVR	3PC_MVR1	WBC/Temp	Ycp = 795.0877, LS = 0.0000, RS = 60.9633, Xcp = 50.0480, R^2 =0.770, CV-RMSE = 19.590%	OK	Ycp = 795.0990, LS = 0.0000, RS = 60.9631, Xcp = 50.0480, R^2 =0.77, CV-RMSE = 19.6%	agree
	3PC_MVR2	WBC/Hum.Ratio	Ycp = 1017.3652, LS = 0.0000, RS = 133112.3125, Xcp = 0.0041, R^2 =0.613, CV-RMSE = 25.428%	OK	Ycp = 1017.3527, LS = 0.0000, RS = 133113.9397, Xcp = 0.0041, R^2 =0.61, CV-RMSE = 25.4%	agree
	3PC_MVR3	WBC/Solar	Ycp = 1887.0750, LS = 0.0000, RS = 0.9254, Xcp = 21.2894, R^2 =0.095, CV-RMSE = 38.889%	OK	Ycp = 1887.0672, LS = 0.0000, RS = 0.9254, Xcp = 21.2894, R^2 =0.10, CV-RMSE = 38.9%	agree
	3PC_MVR4	WBC/WBH	Ycp = 2512.1580, LS = 0.0000, RS = -2.0852, Xcp = 19.3800, R^2 =0.435, CV-RMSE = 30.727%	OK	Ycp = 2512.1302, LS = 0.0000, RS = -2.0851, Xcp = 19.3800, R^2 =0.44, CV-RMSE = 30.7%	agree
	3PC_MVR5	WBC/WBE	Ycp = 976.0828, LS = 0.0000, RS = 3.8803, Xcp = 530.6744, R^2 =0.382, CV-RMSE = 32.133%	OK	Ycp = 976.0774, LS = 0.0000, RS = 3.8804, Xcp = 530.6744, R^2 =0.38, CV-RMSE = 32.1%	agree
	3PC_MVR6	WBC/(temp, hum.ratio, solar, WBH, WBE)	N/A	Stop	N/A	N/A
	3PC_MVR7	WBC/(temp, hum.ratio, solar, WBH)	Ycp = 604.8068, LS = 0.0000, RS = 42.0486, Xcp = 56.0448, X2 = 65233.5039, X3 = 0.2642, X4 = -0.0899, R^2 = 0.838, CV_RMSE = 16.483%	OK	N/A	N/A
3PH/MVR	3PH_MVR1	WBH/temp	Ycp = 47.5498, LS = -18.356, RS = 0.0000, Xcp = 78.5328, R^2 =0.556, CV-RMSE = 76.806%	OK	Ycp = 47.5497, LS = -18.3562, RS = 0.0000, Xcp = 78.5328, R^2 =0.56, CV-RMSE = 76.8%	agree
	3PH_MVR2	WBH/Hum.Ratio	Ycp = 36.6893, LS = -40973.7813, RS = 0.0000, Xcp = 0.0161, R^2 =0.443, CV-RMSE = 86.006%	OK	Ycp = 36.6869, LS = -40974.2867, RS = 0.0000, Xcp = 0.0161, R^2 =0.44, CV-RMSE = 86.0%	agree
	3PH_MVR3	WBH/Solar	Ycp = 143.3547, LS = -0.1088, RS = 0.0000, Xcp = 1021.8912, R^2 =0.014, CV-RMSE = 114.480%	OK	Ycp = 141.0558, LS = -0.1088, RS = 0.0000, Xcp = 1043.1806, R^2 =0.01, CV-RMSE = 114.5%	agree
	3PH_MVR4	WBH/temp, hum.ratio, solar	Ycp = 157.5026, LS = -14.5659, RS = 0.0000, Xcp = 81.5312, X2 =-10100.2783, X3 = 0.0735, R^2 =0.584, CV-RMSE = 74.369%	OK	N/A	N/A

Table 6.1: Four-parameter change-point with multiple variable regression model (4P/MVR)

			IMT		EModel			Status		
TEST		**Data Type**	**IMT file**	**Data File**	**Data File**	**.DVN File**	**Output**	**IMT**	**EModel**	**Comment for IMT**
4PC/MVR	4PC_MVR1	WBC/Temp	4PC_Mvr1.ins	4PC_Mvr1.dat	4PC_Mvr1.dat	4PC_Mvr1.dvn	4PC_Mvr1.doc	OK	agree	
	4PC_MVR2	WBC/Hum.Ratio	4PC_Mvr2.ins	4PC_Mvr2.dat	4PC_Mvr2.dat	4PC_Mvr2.dvn	4PC_Mvr2.doc	OK	agree	
	4PC_MVR3	WBC/Solar	4PC_Mvr3.ins	4PC_Mvr3.dat	4PC_Mvr3.dat	4PC_Mvr3.dvn	4PC_Mvr3.doc	OK	agree	
	4PC_MVR4	WBC/WBH	4PC_Mvr4.ins	4PC_Mvr4.dat	4PC_Mvr4.dat	4PC_Mvr4.dvn	4PC_Mvr4.doc	OK	agree	
	4PC_MVR5	WBC/WBE	4PC_Mvr5.ins	4PC_Mvr5.dat	4PC_Mvr5.dat	4PC_Mvr5.dvn	4PC_Mvr5.doc	OK	agree	
	4PC_MVR6	WBC/(temp, hum.ratio, solar, WBH, WBE)	4PC_Mvr6.ins	4PC_Mvr6.dat	N/A	N/A	N/A	Stop	N/A	For 4P model, Number of X variables must be greater than 0 and less than 4.
	4PC_MVR7	WBC/(temp, hum.ratio, solar)	4PC_Mvr7.ins	4PC_Mvr7.dat	N/A	N/A	N/A	OK	N/A	
4PH/MVR	4PH_MVR1	WBH/temp	4PH_Mvr1.ins	4PH_Mvr1.dat	4PH_Mvr1.dat	4PH_Mvr1.dvn	4PH_Mvr1.doc	OK	agree	
	4PH_MVR2	WBH/Hum.Ratio	4PH_Mvr2.ins	4PH_Mvr2.dat	4PH_Mvr2.dat	4PH_Mvr2.dvn	4PH_Mvr2.doc	OK	agree	
	4PH_MVR3	WBH/Solar	4PH_Mvr3.ins	4PH_Mvr3.dat	4PH_Mvr3.dat	4PH_Mvr3.dvn	4PH_Mvr3.doc	OK	agree	
	4PH_MVR4	WBH/(temp, hum.ratio, solar)	4PH_Mvr4.ins	4PH_Mvr4.dat	N/A	N/A	N/A	OK	N/A	

Table 6.2: Four-parameter change-point with multiple variable regression model (4P/MVR)

TEST		Data Type	IMT		EModel	
4PC/MVR	4PC_MVR1	WBC/Temp	Ycp = 1041.2838, LS = 20.1739, RS = 62.1365, Xcp = 54.5456, R^2 =0.772, CV-RMSE = 19.539%	OK	Ycp = 1041.4609, LS = 20.2269, RS = 62.1283, Xcp = 54.5456, R^2 =0.77, CV-RMSE = 19.5%	agree
	4PC_MVR2	WBC/Hum.Ratio	Ycp = 3038.7427, LS = 133298.4219, RS = 28105.3594, Xcp = 0.0191, R^2 =0.614, CV-RMSE = 25.403%	OK	Ycp = 3038.7405, LS = 133298.3360, RS = 28104.6640, Xcp = 0.0191, R^2 =0.61, CV-RMSE = 25.4%	agree
	4PC_MVR3	WBC/Solar	Ycp = 2198.5732, LS = 9.1839, RS = 0.4249, Xcp = 42.5788, R^2 =0.117, CV-RMSE = 38.427%	OK	Ycp = 2198.1833, LS = 9.1725, RS = 0.4253, Xcp = 42.5788, R^2 =0.12, CV-RMSE = 38.4%	agree
	4PC_MVR4	WBC/WBH	Ycp = 1561.4342, LS = -10.4266, RS = -0.5610, Xcp = 140.9000, R^2 =0.580, CV-RMSE = 26.485%	OK	Ycp = 1561.9606, LS = -10.4200, RS = -0.5621, Xcp = 140.9000, R^2 =0.58, CV-RMSE = 26.5%	agree
	4PC_MVR5	WBC/WBE	Ycp = 2297.9739, LS = 7.7264, RS = 1.6664, Xcp = 791.7968, R^2 =0.455, CV-RMSE = 30.171%	OK	Ycp = 2297.7176, LS = 7.7225, RS = 1.6678, Xcp = 791.7968, R^2 =0.46, CV-RMSE = 30.2%	agree
	4PC_MVR6	WBC/(temp, hum.ratio, solar, WBH, WBE)	N/A	Stop	N/A	N/A
	4PC_MVR7	WBC/(temp, hum.ratio, solar)	Ycp = 632.2288, LS = 9.2148, RS = 43.2151, Xcp = 57.5440, X2 = 65536.2734, X3 = 0.2506, R^2 = 0.838, CV-RMSE = 16.464%	OK	N/A	N/A
4PH/MVR	4PH_MVR1	WBH/temp	Ycp = 74.4480, LS = -18.3837, RS = -3.3026, Xcp = 77.0336, R^2 =0.772, CV-RMSE = 19.539%	OK	Ycp = 74.4114, LS = -18.3867, RS = -3.2995, Xcp = 77.0336, R^2 =0.56, CV-RMSE = 76.7%	agree
	4PH_MVR2	WBH/Hum.Ratio	Ycp = 341.5157, LS = -75755.0625, RS = -27462.0859, Xcp = 0.0071, R^2 =0.449, CV-RMSE = 85.563%	OK	Ycp = 341.5722, LS = -75709.9671, RS = -27469.4929, Xcp = 0.0071, R^2 =0.45, CV-RMSE = 85.6%	agree
	4PH_MVR3	WBH/Solar	Ycp = 215.8252, LS = -0.0468, RS = -0.7951, Xcp = 723.8395, R^2 =0.021, CV-RMSE = 114.085%	OK	Ycp = 215.8266, LS = -0.0468, RS = -0.7951, Xcp = 723.8396, R^2 =0.02, CV-RMSE = 114.1%	agree
	4PH_MVR4	WBH/(temp, hum.ratio, solar)	Ycp = 489.4759, LS = -22.7663, RS = -9.3594, Xcp = 56.0448, X2 = -12879.3535, X3 = 0.0078, R^2 =0.592, CV-RMSE = 73.610%	OK	N/A	N/A

Table 7.1: LoanSTAR data sets using several models (1P, 2P, 3PC, 3PH, 4P, and 5P)

			IMT		EModel			SAS		Status			
TEST		**Data Type**	**IMT file**	**Data File**	**Data File**	**.DVN File**	**Output**	**SAS file**	**SAS Output**	**IMT**	**EModel**	**SAS**	**Comment**
1P	1P_comp1	711: wbe	711.ins	711.dat	711.dat	711.dvn	711.doc	711.sas	711_out.lst	OK	agree	agree	
	1P_comp2	963: wbe	963.ins	963.dat	963.dat	963.dvn	963.doc	963.sas	963_out.lst	OK	agree	agree	
	1P_comp3	208: mcc	208_2.ins	208_2.dat	208_2.dat	208_2.dvn	208_2.doc	208_2.sas	208_2_out.lst	OK	agree	agree	
	1P_comp4	210: mcc	210_1.ins	210_1.dat	210_1.dat	210_1.dvn	210_1.doc	210_1.sas	210_1_out.lst	OK	agree	agree	
2P	2P_comp1	226: wbc/temp	226.ins	226.dat	226.dat	226.dvn	226.doc	226.sas	226_out.lst	OK	agree	agree	
	2P_comp2	201: wbh/temp	201.ins	201.dat	201.dat	201.dvn	201.doc	201.sas	201_out.lst	OK	agree	agree	
	2P_comp3	952: wbe/temp	952.ins	952.dat	952.dat	952.dvn	952.doc	952.sas	952_out.lst	OK	agree	agree	
	2P_comp4	207: wbc/temp	207_1.ins	207_1.dat	207_1.dat	207_1.dvn	207_1.doc	207_1.sas	207_1_out.lst	OK	agree	agree	
	2P_comp5	207: wbh/temp	207_2.ins	207_2.dat	207_2.dat	207_2.dvn	207_2.doc	207_2.sas	207_2_out.lst	OK	agree	agree	
3PC	3PC_comp1	706: wbe/temp	706.ins	706.dat	706.dat	706.dvn	706.doc	N/A	N/A	OK	agree	-	
	3PC_comp2	208: wbc/temp	208_1.ins	208_1.dat	208_1.dat	208_1.dvn	208_1.doc	N/A	N/A	OK	agree	-	
	3PC_comp3	209: wbc/temp	209.ins	209.dat	209.dat	209.dvn	209.doc	N/A	N/A	OK	agree	-	
3PH	3PH_comp1	707: wbh/temp	707.ins	707.dat	707.dat	707.dvn	707.doc	N/A	N/A	OK	agree	-	
	3PH_comp2	208: wbh/temp	208_3.ins	208_3.dat	208_3.dat	208_3.dvn	208_3.doc	N/A	N/A	OK	agree	-	
4P	4P_comp1	208: wbc/temp	208_4.ins	208_4.dat	208_4.dat	208_4.dvn	208_4.doc	N/A	N/A	OK	agree	-	
	4P_comp2	975: wbc/temp	975.ins	975.dat	975.dat	975.dvn	975.doc	N/A	N/A	OK	agree	-	
	4P_comp3	201: wbc/temp	201.ins	201.dat	201.dat	201.dvn	201.doc	N/A	N/A	OK	agree	-	
	4P_comp4	205: wbc/temp	205.ins	205.dat	205.dat	205.dvn	205.doc	N/A	N/A	OK	agree	-	
5P	5P_comp1	210: wbc/temp	210_2.ins	210_2.dat	N/A	N/A	N/A	N/A	N/A	OK	N/A	-	
	5P_comp2	710: wbe/temp	710.ins	710.dat	N/A	N/A	N/A	N/A	N/A	OK	N/A	-	

Table 7.2: LoanSTAR data sets using several models (1P, 2P, 3PC, 3PH, 4P, and 5P)

TEST		Data Type	IMT		EModel		SAS	
1P	1P_comp1	711: wbe	Ymean = 25409.281, StdDev = 2391.109, CV-StDev = 9.410%	OK	Ymean = 25409.28, StdDev = 2391.11, CV-StDev = 9.4%	agree	Ymean = 25409.2809, StdDev = 2391.1088, CV-StDev = 9.41037572%	agree
	1P_comp2	963: wbe	Ymean = 1118.391, StdDev = 452.392, CV-StDev = 40.450%	OK	Ymean = 1118.39, StdDev = 452.39, CV-StDev = 40.5%	agree	Ymean = 1118.39048, StdDev = 452.392131, CV-StDev = 40.4502846%	agree
	1P_comp3	208: mcc	Ymean = 1253.028, StdDev = 152.335, CV-StDev = 12.157%	OK	Ymean = 1253.03, StdDev = 152.33, CV-StDev = 12.2%	agree	Ymean = 1252.50279, StdDev = 152.222448, CV-StDev = 12.1534618%	agree
	1P_comp4	210: mcc	Ymean = 2573.383, StdDev = 72.946, CV-StDev = 2.835%	OK	Ymean = 2573.38, StdDev = 72.95, CV-StDev = 2.8%	agree	Ymean = 2573.29006, StdDev = 73.0254868, CV-StDev = 2.83782571%	agree
2P	2P_comp1	226: wbc/temp	Yint = -10227.1260, Slope = 470.2920, R^2 = 0.834, CV-RMSE = 13.538%	OK	Yint = -10228.5602, Slope = 470.3123, R^2 = 0.83, CV-RMSE = 13.5%	agree	Yint = -10229, Slope = 470.31234, R^2 = 0.8338, CV-RMSE = 13.53846%	agree
	2P_comp2	201: wbh/temp	Yint = 68439.5078, Slope = -649.0869, R^2 = 0.691, CV-RMSE = 24.767%	OK	Yint = 68439.4669, Slope = -649.0859, R^2 = 0.69, CV-RMSE = 24.8%	agree	Yint = 68439, Slope = -649.08587, R^2 = 0.6906, CV-RMSE = 24.76693%	agree
	2P_comp3	952: wbe/temp	Yint = 2338.5520, Slope = 212.1381, R^2 = 0.728, CV-RMSE = 11.645%	OK	Yint = 2338.4196, Slope = 212.1397, R^2 = 0.73, CV-RMSE = 11.6%	agree	Yint = 2338.41956, Slope = 212.13968, R^2 = 0.7280, CV-RMSE = 11.64547%	agree
	2P_comp4	207: wbc/temp	Yint = -5041.9448, Slope = 105.2378, R^2 = 0.861, CV-RMSE = 27.592%	OK	Yint = -5041.7452, Slope = 105.2349, R^2 = 0.86, CV-RMSE = 27.6%	agree	Yint = -5041.74522, Slope = 105.23485, R^2 = 0.8607, CV-RMSE = 27.59200%	agree
	2P_comp5	207: wbh/temp	Yint = 23192.1055, Slope = -219.9567, R^2 = 0.691, CV-RMSE = 24.767%	OK	Yint = 23192.0949, Slope = -219.9563, R^2 = 0.69, CV-RMSE = 24.8%	agree	Yint = 23192, Slope = -219.95630, R^2 = 0.6906, CV-RMSE = 24.76704%	agree
3PC	3PC_comp1	706: wbe/temp	Ycp = 2417.5983, LS = 0.0000, RS = 87.6157, Xcp = 56.7600, R^2 = 0.339, CV-RMSE = 30.578%	OK	Ycp = 2417.5941, LS = 0.0000, RS = 87.6158, Xcp = 56.7600, R^2 = 0.34, CV-RMSE = 30.6%	agree	N/A	-
	3PC_comp2	208: wbc/temp	Ycp = 11145.4775, LS = 0.0000, RS = 945.5939, Xcp = 59.7600, R^2 = 0.855, CV-RMSE = 18.214%	OK	Ycp = 11145.4541, LS = 0.0000, RS = 945.5957, Xcp = 59.7600, R^2 = 0.85, CV-RMSE = 18.2%	agree	N/A	-
	3PC_comp3	209: wbc/temp	Ycp = 78198.4688, LS = 0.0000, RS = 2117.7173, Xcp = 52.2000, R^2 = 0.768, CV-RMSE = 12.495%	OK	Ycp = 78198.5274, LS = 0.0000, RS = 2117.7136, Xcp = 52.2000, R^2 = 0.77, CV-RMSE = 12.5%	agree	N/A	-
3PH	3PH_comp1	707: wbh/temp	Ycp = 10248.5869, LS = -8369.0127, RS = 0.0000, Xcp = 61.6800, R^2 = 0.934, CV-RMSE = 26.455%	OK	Ycp = 10248.4245, LS = -8369.0158, RS = 0.0000, Xcp = 61.6800, R^2 = 0.93, CV-RMSE = 26.5%	agree	N/A	-
	3PH_comp2	208: wbh/temp	Ycp = 6001.7227, LS = -639.4753, RS = 0.0000, Xcp = 79.9200, R^2 = 0.951, CV-RMSE = 13.166%	OK	Ycp = 6001.7111, LS = -639.4761, RS = 0.0000, Xcp = 79.9200, R^2 = 0.95, CV-RMSE = 13.2%	agree	N/A	-
4P	4P_comp1	208: wbc/temp	Ycp = 17613.2813, LS = 343.6089, RS = 1081.8597, Xcp = 68.5800, R^2 = 0.873, CV-RMSE = 17.054%	OK	Ycp = 17613.7419, LS = 343.6469, RS = 1081.8386, Xcp = 68.5800, R^2 = 0.87, CV-RMSE = 17.1%	agree	N/A	-
	4P_comp2	975: wbc/temp	Ycp = 1529.8441, LS = 16.8140, RS = 73.5243, Xcp = 69.1200, R^2 = 0.816, CV-RMSE = 13.204%	OK	Ycp = 1529.8660, LS = 16.8142, RS = 73.5246, Xcp = 69.1200, R^2 = 0.82, CV-RMSE = 13.2%	agree	N/A	-
	4P_comp3	201: wbc/temp	Ycp = 27831.1035, LS = 562.6268, RS = 1278.6936, Xcp = 61.6000, R^2 = 0.754, CV-RMSE = 20.844%	OK	Ycp = 27831.8523, LS = 562.7605, RS = 1278.6456, Xcp = 61.6000, R^2 = 0.75, CV-RMSE = 20.8%	agree	N/A	-
	4P_comp4	205: wbc/temp	Ycp = 9191.9424, LS = 61.4300, RS = 173.2227, Xcp = 68.6200, R^2 = 0.850, CV-RMSE = 6.125%	OK	Ycp = 9191.8404, LS = 61.4281, RS = 173.2247, Xcp = 68.6200, R^2 = 0.85, CV-RMSE = 6.1%	agree	N/A	-
5P	5P_comp1	210: wbc/temp	Xcp1 = 62.0000, Xcp2 = 69.0000, Ycp = 100499.6250, LS = -635.1901, RS = 2534.4150, R^2 = 0.699, CV-RMSE = 9.511%	OK	N/A	N/A	N/A	-
	5P_comp2	710: wbe/temp	Xcp1 = 58.7007, Xcp2 = 61.7438, Ycp = 11665.7363, LS = -120.6786, RS = 47.0371, R^2 = 0.274, CV-RMSE = 21.866%	OK	N/A	N/A	N/A	-

Table 8.1: Variable-Base Cooling Degree-Day (CDD) and the CDD with multiple variable regression models (CDD/MVR)

			IMT		PRISM			Status		
TEST		**Data Type**	**IMT file**	**Data File**	**Meter File**	**Weather File**	**Output**	**IMT**	**PRISM**	**Comment**
CDD (Q)	VBDD_C1	WBE	VBDD_C1.ins	VBDD_C1.dat	1308el_1.mtr	Bcs_1.tps	VBDD_C1.doc	OK	agree	
	VBDD_C3	WBE	VBDD_C3.ins	VBDD_C3.dat	1308el_3.mtr	Bcs_1.tps	VBDD_C3.doc	OK	agree	
	VBDD_C4	WBE	VBDD_C4.ins	VBDD_C4.dat	1308el_4.mtr	Bcs_1.tps	VBDD_C4.doc	OK	agree	
	VBDD_C5	WBE	VBDD_C5.ins	VBDD_C5.dat	1308el_5.mtr	Bcs_1.tps	VBDD_C5.doc	OK	agree	
	VBDD_C6	WBE	VBDD_C6.ins	VBDD_C6.dat	1308el_6.mtr	Bcs_1.tps	VBDD_C6.doc	OK	agree	
	VBDD_C7	WBE	VBDD_C7.ins	VBDD_C7.dat	1308el_7.mtr	Bcs_1.tps	VBDD_C7.doc	OK	agree	
	VBDD_C8	WBE	VBDD_C8.ins	VBDD_C8.dat	1308el_8.mtr	Bcs_1.tps	VBDD_C8.doc	OK	agree	
	VBDD_C9	WBE	VBDD_C9.ins	VBDD_C9.dat	1308el_9.mtr	Bcs_1.tps	VBDD_C9.doc	OK	agree	
	VBDD_C10	WBE	VBDD_C10.ins	VBDD_C10.dat	1308el_10.mtr	Bcs_1.tps	VBDD_C10.doc	OK	agree	
	VBDD_C11	WBE	VBDD_C11.ins	VBDD_C11.dat	1308el_11.mtr	Bcs_1.tps	VBDD_C11.doc	OK	agree	
	VBDD_C12	WBE	VBDD_C12.ins	VBDD_C12.dat	1308el_12.mtr	Bcs_1.tps	VBDD_C12.doc	OK	agree	
	VBDD_C13	WBE	VBDD_C13.ins	VBDD_C13.dat	1308el_13.mtr	Bcs_1.tps	VBDD_C13.doc	OK	agree	
CDD (Q/day)	VBDD_C1d	WBE	VBDD_C1d.ins	VBDD_C1d.dat	1308el_1.mtr	Bcs_1.tps	VBDD_C1.doc	OK	agree	
	VBDD_C2d	WBE	VBDD_C2d.ins	VBDD_C2d.dat	1308el_2.mtr	Bcs_1.tps	VBDD_C2.doc	OK	agree	
	VBDD_C3d	WBE	VBDD_C3d.ins	VBDD_C3d.dat	1308el_3.mtr	Bcs_1.tps	VBDD_C3.doc	OK	agree	
	VBDD_C4d	WBE	VBDD_C4d.ins	VBDD_C4d.dat	1308el_4.mtr	Bcs_1.tps	VBDD_C4.doc	OK	agree	
	VBDD_C5d	WBE	VBDD_C5d.ins	VBDD_C5d.dat	1308el_5.mtr	Bcs_1.tps	VBDD_C5.doc	OK	agree	
	VBDD_C6d	WBE	VBDD_C6d.ins	VBDD_C6d.dat	1308el_6.mtr	Bcs_1.tps	VBDD_C6.doc	OK	agree	
	VBDD_C7d	WBE	VBDD_C7d.ins	VBDD_C7d.dat	1308el_7.mtr	Bcs_1.tps	VBDD_C7.doc	OK	agree	
	VBDD_C8d	WBE	VBDD_C8d.ins	VBDD_C8d.dat	1308el_8.mtr	Bcs_1.tps	VBDD_C8.doc	OK	agree	
	VBDD_C9d	WBE	VBDD_C9d.ins	VBDD_C9d.dat	1308el_9.mtr	Bcs_1.tps	VBDD_C9.doc	OK	agree	
	VBDD_C10d	WBE	VBDD_C10d.ins	VBDD_C10d.dat	1308el_10.mtr	Bcs_1.tps	VBDD_C10.doc	OK	agree	
	VBDD_C11d	WBE	VBDD_C11d.ins	VBDD_C11d.dat	1308el_11.mtr	Bcs_1.tps	VBDD_C11.doc	OK	agree	
	VBDD_C12d	WBE	VBDD_C12d.ins	VBDD_C12d.dat	1308el_12.mtr	Bcs_1.tps	VBDD_C12.doc	OK	agree	
	VBDD_C13d	WBE	VBDD_C13d.ins	VBDD_C13d.dat	1308el_13.mtr	Bcs_1.tps	VBDD_C13.doc	OK	agree	
CDD/MVR	CDD_MVR1	WBC/Temp	CDD_Mvr1.ins	CDD_Mvr1.dat	N/A	N/A	N/A	OK	N/A	
	CDD_MVR2	WBC/Hum.Ratio	CDD_Mvr2.ins	CDD_Mvr2.dat	N/A	N/A	N/A	Stop	N/A	Error in Subroutine Invert. Matrix is singular
	CDD_MVR3	WBC/Solar	CDD_Mvr3.ins	CDD_Mvr3.dat	N/A	N/A	N/A	OK	N/A	
	CDD_MVR4	WBC/(temp, hum.ratio, solar)	CDD_Mvr4.ins	CDD_Mvr4.dat	N/A	N/A	N/A	Error	N/A	IMT ignores X2 and X3. Only X1 is used in the calculation. The .INS and output files show different parameters.
	CDD_MVR5	WBC/(temp, hum.ratio, solar)	CDD_Mvr5.ins	CDD_Mvr5.dat	N/A	N/A	N/A	OK	N/A	Use CDD residual file as input to the MVR model to mimic CDD-MVR capabilities

Table 8.2: Variable-Base Cooling Degree-Day Model (CDD)

TEST		Data Type	IMT		PRISM	
CDD (Q)	VBDD_C1	WBE	DD = 70, Base Use = 479.7767, Cooling Slope = 2.2761, R^2 = 0.971	OK	DD = 69, Base Use = 16.05/day, Cooling Slope = 2.18, R^2 = 0.9516	DD & Slope agree
	VBDD_C2	WBE	DD = 70, Base Use = 487.9663, Cooling Slope = 2.2588, R^2 = 0.973	OK	DD = 69, Base Use = 15.91/day, Cooling Slope = 2.19, R^2 = 0.9527	DD & Slope agree
	VBDD_C3	WBE	DD = 70, Base Use = 501.4227, Cooling Slope = 2.2278, R^2 = 0.972	OK	DD = 69, Base Use = 16.30/day, Cooling Slope = 2.16, R^2 = 0.9534	DD & Slope agree
	VBDD_C4	WBE	DD = 72, Base Use = 494.6992, Cooling Slope = 2.5731, R^2 = 0.964	OK	DD = 69, Base Use = 15.84/day, Cooling Slope = 2.19, R^2 = 0.9514	DD & Slope agree
	VBDD_C5	WBE	DD = 73, Base Use = 497.9115, Cooling Slope = 2.7893, R^2 = 0.964	OK	DD = 70, Base Use = 15.84/day, Cooling Slope = 2.35, R^2 = 0.9515	DD & Slope agree
	VBDD_C6	WBE	DD = 71, Base Use = 482.4804, Cooling Slope = 2.3642, R^2 = 0.956	OK	DD = 70.26, Base Use = 15.87/day, Cooling Slope = 2.31, R^2 = 0.9602	DD & Slope agree
	VBDD_C7	WBE	DD = 71, Base Use = 482.5603, Cooling Slope = 2.1845, R^2 = 0.892	OK	DD = 69.78, Base Use = 16.04/day, Cooling Slope = 1.96, R^2 = 0.9194	DD & Slope agree
	VBDD_C8	WBE	DD = 69, Base Use = 481.3739, Cooling Slope = 1.6488, R^2 = 0.849	OK	DD = 69.00, Base Use = 15.93/day, Cooling Slope = 1.80, R^2 = 0.9140	DD & Slope agree
	VBDD_C9	WBE	DD = 70, Base Use = 468.6212, Cooling Slope = 1.9651, R^2 = 0.871	OK	DD = 69.14, Base Use = 15.86/day, Cooling Slope = 1.92, R^2 = 0.8879	DD & Slope agree
	VBDD_C10	WBE	DD = 70, Base Use = 462.1427, Cooling Slope = 1.9794, R^2 = 0.868	OK	DD = 69.33, Base Use = 15.91/day, Cooling Slope = 1.87, R^2 = 0.8932	DD & Slope agree
	VBDD_C11	WBE	DD = 70, Base Use = 490.9287, Cooling Slope = 1.9138, R^2 = 0.852	OK	DD = 68.66, Base Use = 15.99/day, Cooling Slope = 1.78, R^2 = 0.8812	DD & Slope agree
	VBDD_C12	WBE	DD = 68, Base Use = 431.1980, Cooling Slope = 1.7898, R^2 = 0.877	OK	DD = 68.50, Base Use = 16.49/day, Cooling Slope = 1.72, R^2 = 0.8888	DD & Slope agree
	VBDD_C13	WBE	DD = 66, Base Use = 470.6246, Cooling Slope = 1.6957, R^2 = 0.880	OK	DD = 66.00, Base Use = 13.94/day, Cooling Slope = 1.62, R^2 = 0.8936	DD & Slope agree
CDD (Q/day)	VBDD_C1d	WBE	DD = 72, Base Use = 17.1774/day, Cooling Slope = 0.0827, R^2 = 0.914	OK	DD = 69, Base Use = 16.05/day, Cooling Slope = 2.18, R^2 = 0.9516	DD & Base Use agree
	VBDD_C2d	WBE	DD = 72, Base Use = 17.2799/day, Cooling Slope = 0.0824, R^2 = 0.914	OK	DD = 69, Base Use = 15.91/day, Cooling Slope = 2.19, R^2 = 0.9527	DD & Base Use agree
	VBDD_C3d	WBE	DD = 72, Base Use = 17.3927/day, Cooling Slope = 0.0821, R^2 = 0.914	OK	DD = 69, Base Use = 16.30/day, Cooling Slope = 2.16, R^2 = 0.9534	DD & Base Use agree
	VBDD_C4d	WBE	DD = 72, Base Use = 16.7694/day, Cooling Slope = 0.0838, R^2 = 0.905	OK	DD = 69, Base Use = 15.84/day, Cooling Slope = 2.19, R^2 = 0.9514	DD & Base Use agree
	VBDD_C5d	WBE	DD = 73, Base Use = 16.8511/day, Cooling Slope = 0.0909, R^2 =0.907	OK	DD = 70, Base Use = 15.84/day, Cooling Slope = 2.35, R^2 = 0.9515	DD & Base Use agree
	VBDD_C6d	WBE	DD = 70, Base Use = 16.0906/day, Cooling Slope = 0.0655, R^2 = 0.923	OK	DD = 70.26, Base Use = 15.87/day, Cooling Slope = 2.31, R^2 = 0.9602	DD & Base Use agree
	VBDD_C7d	WBE	DD = 70, Base Use = 16.1181/day, Cooling Slope = 0.0613, R^2 = 0.892	OK	DD = 69.78, Base Use = 16.04/day, Cooling Slope = 1.96, R^2 = 0.9194	DD & Base Use agree
	VBDD_C8d	WBE	DD = 70, Base Use = 16.2195/day, Cooling Slope = 0.0593, R^2 = 0.853	OK	DD = 69.00, Base Use = 15.93/day, Cooling Slope = 1.80, R^2 = 0.9140	DD & Base Use agree
	VBDD_C9d	WBE	DD = 71, Base Use = 15.8395/day, Cooling Slope = 0.0657, R^2 = 0.925	OK	DD = 69.14, Base Use = 15.86/day, Cooling Slope = 1.92, R^2 = 0.8879	DD & Base Use agree
	VBDD_C10d	WBE	DD = 70, Base Use = 15.5676/day, Cooling Slope = 0.0617, R^2 = 0.920	OK	DD = 69.33, Base Use = 15.91/day, Cooling Slope = 1.87, R^2 = 0.8932	DD & Base Use agree
	VBDD_C11d	WBE	DD = 70, Base Use = 16.6691/day, Cooling Slope = 0.0591, R^2 = 0.912	OK	DD = 68.66, Base Use = 15.99/day, Cooling Slope = 1.78, R^2 = 0.8812	DD & Base Use agree
	VBDD_C12d	WBE	DD = 70, Base Use = 15.7325/day, Cooling Slope = 0.0618, R^2 = 0.924	OK	DD = 68.50, Base Use = 16.49/day, Cooling Slope = 1.72, R^2 = 0.8888	DD & Base Use agree
	VBDD_C13d	WBE	DD = 66, Base Use = 12.5029/day, Cooling Slope = 0.0534, R^2 = 0.922	OK	DD = 66.00, Base Use = 13.94/day, Cooling Slope = 1.62, R^2 = 0.8936	DD & Base Use agree

Table 8.3: CDD with multiple variable regression models (CDD/MVR)

TEST		Data Type	IMT	
CDD/MVR	CDD_MVR1	WBC/Temp	DD = 55, Base Use = 21861.4785, Cooling Slope = 1727.6812, R2 = 0.90, CV-RMSE = 12.064%	OK
	CDD_MVR2	WBC/Hum.Ratio	N/A	Stop
	CDD_MVR3	WBC/Solar	DD = 80, Base Use = 30885.9727, Cooling Slope = 3.8399, R^2 = 0.145, CV-RMSE = 35.235%	OK
	CDD_MVR4	WBC/(temp, hum.ratio, solar)	N/A	Error
	CDD_MVR5	WBC/(temp, hum.ratio, solar)	a = -26437.8164, X1 = 713.8923, X2 = 1332734.1250, X3 = 1.9659, R2 = 0.771, CV-RMSE = 17.675%	OK

Table 9.1: Variable-Base Heating Degree-Day (HDD) and the HDD with multiple variable regression models (HDD/MVR)

			IMT		PRISM			Status		
TEST		**Data Type**	**IMT file**	**Data File**	**Meter File**	**Weather File**	**Output**	**IMT**	**PRISM**	**Comment**
HDD	VBDD_H1	GAS	VBDD_H1.ins	VBDD_H1.dat	1308ng_1.mtr	Bcs_1.tps	VBDD_H1.doc	OK	agree	
(Q)	VBDD_H2	GAS	VBDD_H2.ins	VBDD_H2.dat	1308ng_2.mtr	Bcs_1.tps	VBDD_H2.doc	OK	agree	
	VBDD_H3	GAS	VBDD_H3.ins	VBDD_H3.dat	1308ng_3.mtr	Bcs_1.tps	VBDD_H3.doc	OK	agree	
	VBDD_H4	GAS	VBDD_H4.ins	VBDD_H4.dat	1308ng_4.mtr	Bcs_1.tps	VBDD_H4.doc	OK	agree	
	VBDD_H5	GAS	VBDD_H5.ins	VBDD_H5.dat	1308ng_5.mtr	Bcs_1.tps	VBDD_H5.doc	OK	close	IMT has a lower DD base by 3 F.
	VBDD_H6	GAS	VBDD_H6.ins	VBDD_H6.dat	1308ng_6.mtr	Bcs_1.tps	VBDD_H6.doc	OK	agree	
HDD	VBDD_H1d	GAS	VBDD_H1d.ins	VBDD_H1d.dat	1308ng_1.mtr	Bcs_1.tps	VBDD_H1.doc	OK	agree	
(Q/day)	VBDD_H2d	GAS	VBDD_H2d.ins	VBDD_H2d.dat	1308ng_2.mtr	Bcs_1.tps	VBDD_H2.doc	OK	agree	
	VBDD_H3d	GAS	VBDD_H3d.ins	VBDD_H3d.dat	1308ng_3.mtr	Bcs_1.tps	VBDD_H3.doc	OK	agree	
	VBDD_H4d	GAS	VBDD_H4d.ins	VBDD_H4d.dat	1308ng_4.mtr	Bcs_1.tps	VBDD_H4.doc	OK	agree	
	VBDD_H5d	GAS	VBDD_H5d.ins	VBDD_H5d.dat	1308ng_5.mtr	Bcs_1.tps	VBDD_H5.doc	OK	close	
	VBDD_H6d	GAS	VBDD_H6d.ins	VBDD_H6d.dat	1308ng_6.mtr	Bcs_1.tps	VBDD_H6.doc	OK	agree	
HDD/MVR	HDD_MVR1	WBH/Temp	HDD_Mvr1.ins	HDD_Mvr1.dat	N/A	N/A	N/A	OK	N/A	
	HDD_MVR2	WBH/Hum.Ratio	HDD_Mvr2.ins	HDD_Mvr2.dat	N/A	N/A	N/A	OK	N/A	
	HDD_MVR3	WBH/Solar	HDD_Mvr3.ins	HDD_Mvr3.dat	N/A	N/A	N/A	Stop	N/A	Error in Subroutine Invert. Matrix is singular
	HDD_MVR4	WBH/(temp, hum.ratio, solar)	HDD_Mvr4.ins	HDD_Mvr4.dat	N/A	N/A	N/A	Error	N/A	IMT ignores X2 and X3. Only X1 is used in the calculation. The .INS and output files show different parameters.
	HDD_MVR5	WBH/(temp, hum.ratio, solar)	HDD_Mvr5.ins	HDD_Mvr5.dat	N/A	N/A	N/A	OK	N/A	Use HDD residual file as input to the MVR model to mimic HDD-MVR capabilities

Table 9.2: Variable-Base Heating Degree-Day Model (HDD)

TEST		Data Type	IMT		PRISM	
HDD (Q)	VBDD_H1	GAS	DD = 69, Base Use = 18.5144, Heating Slope = 0.1689	OK	DD = 69.79, Base Use = 0.72/day, Heating Slope = 0.15, R^2 = 0.9841	DD & Slope agree
	VBDD_H2	GAS	DD = 69, Base Use = 17.5255, Heating Slope = 0.1712	OK	DD = 70.30, Base Use = 0.66/day, Heating Slope = 0.15, R^2 = 0.9822	DD & Slope agree
	VBDD_H3	GAS	DD = 70, Base Use = 15.5614, Heating Slope = 0.1653	OK	DD = 70.59, Base Use = 0.62/day, Heating Slope = 0.15, R^2 = 0.9817	DD & Slope agree
	VBDD_H4	GAS	DD = 70, Base Use = 15.3872, Heating Slope = 0.1657	OK	DD = 70.00, Base Use = 0.62/day, Heating Slope = 0.16, R^2 = 0.9811	DD & Slope agree
	VBDD_H5	GAS	DD = 68, Base Use = 15.8379, Heating Slope = 0.1805	OK	DD = 70.00, Base Use = 0.60/day, Heating Slope = 0.15, R^2 = 0.9668	close
	VBDD_H6	GAS	DD = 66, Base Use = 16.3870, Heating Slope = 0.1922	OK	DD = 66.00, Base Use = 0.64/day, Heating Slope = 0.18, R^2 = 0.8757	DD & Slope agree
HDD (Q/day)	VBDD_H1d	GAS	DD = 70, Base Use = 0.6979/day, Heating Slope = 0.0050, R^2 =0.957	OK	DD = 69.79, Base Use = 0.72/day, Heating Slope = 0.15, R^2 = 0.9841	DD & Base Use agree
	VBDD_H2d	GAS	DD = 70, Base Use = 0.6458/day, Heating Slope = 0.0051, R^2 = 0.957	OK	DD = 70.30, Base Use = 0.66/day, Heating Slope = 0.15, R^2 = 0.9822	DD & Base Use agree
	VBDD_H3d	GAS	DD = 70, Base Use = 0.6245/day, Heating Slope = 0.0051, R^2 = 0.959	OK	DD = 70.59, Base Use = 0.62/day, Heating Slope = 0.15, R^2 = 0.9817	DD & Base Use agree
	VBDD_H4d	GAS	DD = 70, Base Use = 0.5954/day, Heating Slope = 0.0052, R^2 = 0.959	OK	DD = 70.00, Base Use = 0.62/day, Heating Slope = 0.16, R^2 = 0.9811	DD & Base Use agree
	VBDD_H5d	GAS	DD = 70, Base Use = 0.6037/day, Heating Slope = 0.0052, R^2 = 0.957	OK	DD = 70.00, Base Use = 0.60/day, Heating Slope = 0.15, R^2 = 0.9668	close
	VBDD_H6d	GAS	DD = 67, Base Use = 0.6496/day, Heating Slope = 0.0057, R^2 = 0.850	OK	DD = 66.00, Base Use = 0.64/day, Heating Slope = 0.18, R^2 = 0.8757	DD & Base Use agree

Table 9.3: HDD with multiple variable regression models (HDD/MVR)

TEST		Data Type	IMT	
HDD/MVR	HDD_MVR1	WBH/Temp	DD = 70, Base Use = 3130.9380, Heating Slope = 562.0746, R2 = 0.507, CV-RMSE = 75.997%	OK
	HDD_MVR2	WBH/Hum.Ratio	DD = 80, Base Use = 6735.5371, Heating Slope = -8.6924, R2 = 0.004, CV-RMSE = 107.999%	OK
	HDD_MVR3	WBH/Solar	N/A	Stop
	HDD_MVR4	WBH/(temp, hum.ratio, solar)	N/A	Error
	HDD_MVR5	WBH/(temp, hum.ratio, solar)	a = 29076.8477, X1 = -303.1802, X2 = -115652.0469, X3 = 0.0730, R^2 = 0.579, CV-RMSE = 50.796%	OK

Table 10.1: Multiple Variable Regression Model (MVR)

			IMT		EModel			SAS		Status			
TEST		**Data Type**	**IMT file**	**Data File**	**Data File**	**.DVN File**	**Output**	**SAS File**	**SAS output**	**IMT**	**Emodel**	**SAS**	**Comment for IMT**
MVR	MVR_0	Synthetic data	MVR_0.ins	MVR_0.dat	MVR_0.dat	MVR_0.dat	MVR_0.dvn	MVR_0.sas	MVR_0.lst	OK	agree	agree	
	MVR_1	WBE/(temp, hum.ratio,solar)	MVR_1.ins	MVR_1.dat	MVR_1.dat	MVR_1.dat	MVR_1.dvn	MVR_1.sas	MVR_1.lst	OK	Overflow	agree	
	MVR_2	WBC/(WBE, WBH, temp, hum.ratio, solar)	MVR_2.ins	MVR_2.dat	MVR_2.dat	MVR_2.dat	MVR_2.dvn	MVR_2.sas	MVR_2.lst	OK	Overflow	agree	
	MVR_3	WBH/(WBE, WBC, temp, hum.ratio, solar)	MVR_3.ins	MVR_3.dat	MVR_3.dat	MVR_3.dat	MVR_3.dvn	MVR_3.sas	MVR_3.lst	OK	Overflow	agree	

Table 10.2: Multiple Variable Regression Model (MVR)

TEST		**Data Type**	**IMT**		**EModel**		**SAS**	
MVR	MVR_0	Synthetic data	a = 1.0000, X1 = 1.0000, X2 = 2.0000, X3 = 3.0000, X4 = 4.0000, X5 = 5.0000, X6 = 6.0000	OK	Yint = 1.0000, X1 = 1.0000, X2 = 2.0000, X3 = 3.0000, X4 = 4.0000, X5 = 5.0000, X6 = 6.0000	agree	Yint = 1.0000, X1 = 1.0000, X2 = 2.0000, X3 = 3.0000, X4 = 4.0000, X5 = 5.0000, X6 = 6.0000	agree
	MVR_1	WBE/(temp, hum.ratio,solar)	a = 473.3068, X1 = 4.6356, X2 = -1992.5603, X3 = 0.1754	OK	N/A	N/A	Yint = 473.228982, X1 = 4.637366, X2 = -1995.942269, X3 = 0.175387	agree
	MVR_2	WBC/(WBE, WBH, temp, hum.ratio, solar)	a = -2354.9236, X1 = 28.4639, X2 = 72907.6406, X3 = -0.0178, X4 = 1.8636, X5 = 0.1787	OK	N/A	N/A	Yint = -2354.82060, X1 = 28.47099, X2 = 72901.36995, X3 = -0.01776, X4 = 1.86297, X5 = 0.17879	agree
	MVR_3	WBH/(WBE, WBC, temp, hum.ratio, solar)	a = 1428.1320, X1 = -12.9370, X2 = -16776.8887, X3 = 0.1297, X4 = -0.2883, X5 = 0.0591	OK	N/A	N/A	Yint = 1428.56701, X1 = -12.94613, X2 = -16788.49610, X3 = 0.12969, X4 = -0.28844, X5 = 0.05928	agree